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FIRE CONTROL GUIDE

WATER HANDLING EQUIPMENT GUIDE

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FOREST SERVICE

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FIRE CONTROL GUIDE

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WATER HANDLING EQUIPMENT GUIDE

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WATER HANDLING EQUIPMENT GUIDE
GANSNER PROGRESSIVE HOSE PACK

April 1980

POSTING INSTRUCTIONS.

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Regional Forester

PREFACE

This GUIDE is a basic source of information on water handling equipment used in forest fire fighting. The descriptions, photographs, and technical data will assist field users in selecting proper equipment. Water handling equipment includes many interrelated items. Large sums of money are spent for original capital investment and replacement each year. Careful selection will insure maximum efficiency and service life.

Other purposes of the GUIDE are to promote standardization and reduce equipment costs. The growing trend toward exchange of firefighters during emergencies and dependence upon many new seasonal firemen has increased the need for use of standardized equipment. Many equipment items listed in the GUIDE are covered under Forest Service specifications, which are based on sound engineering design concepts and field requirements. Copies of these specifications are available to other agencies or to individuals from any Forest Service Regional Office or from the Washington Office. Related construction drawings are maintained and are available from San Dimas Equipment Development Center. Use of specifications and drawings will help insure procurement of quality equipment at reduced cost. The Forest Service is committed to use standardized equipment covered by these specifications as much as possible.

The GUIDE is designed primarily for Forest Service personnel, but other fire agencies may find the material helpful. The original text and amendments were prepared under the sponsorship of the Director, Division of Fire Control, Washington, D.C., by personnel at the San Dimas Equipment Development Center.

GUIDE amendments will be issued each year by December 1. Printing of the GUIDE and amendments is handled by the San Dimas Equipment Development Center under the direction of the Washington Office. Regional Foresters for Regions 1, 2, 3, 4, 5, 6, and 10 are responsible for maintaining up-to-date mailing lists for all GUIDE users in their Regions. Regions 8 and 9 are each responsible for maintaining a list of In-Service users. Area Directors at Upper Darby, Pennsylvania (Northeastern Area, S&PF) and Atlanta, Georgia (Southeastern Area, S&PF) should maintain distribution lists for all Out-Service users in their areas. The final distribution of GUIDES and amendments is handled by the respective Regional Foresters and Area Directors.

M. M. Nelson

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SECTION REFERENCE

GUIDE USE INSTRUCTIONS

- Find the general section in the simplified index.
- Bend the right edge back.
- Flip the pages to the selected black tab for the correct location.
- A complete Table of Contents follows this page.

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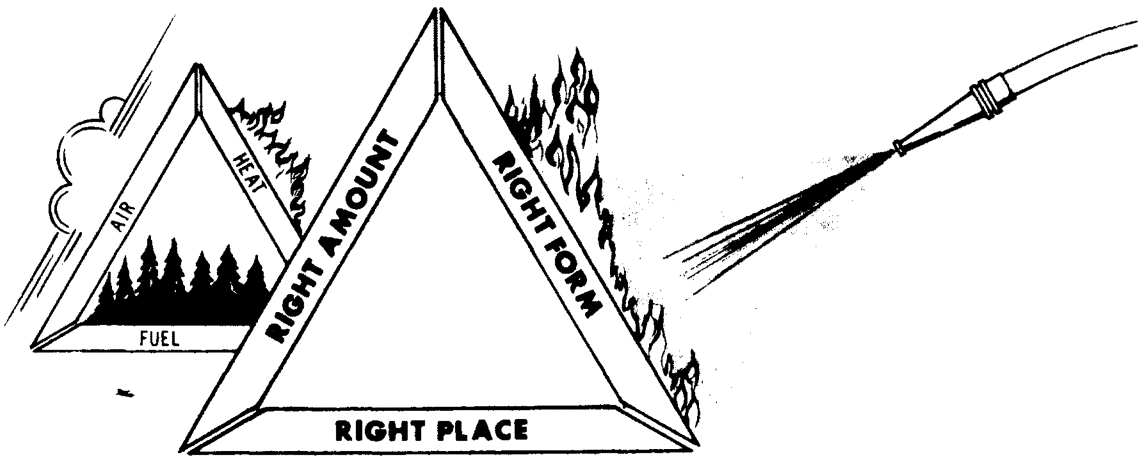
INTRODUCTION

1.0 - FIRE = FUEL + AIR + HEAT. "Fire cannot exist in the absence of heat, fuel, or air. The basic principle of fire suppression is to remove heat or fuel or air in the quickest and most effective manner," as outlined in the FIREMAN'S HANDBOOK (FSH 5109.12).

"SECOND FIRE TRIANGLE." Water is the best all-round cooling agent (NFPA, 1951) and has been used for generations as a most effective firefighting tool. Water ". . . can be applied by hand, as from a bucket, by pressure exerted upon it, as with a [backpack] pump or compressed air or gas, and it may be delivered by gravity from an elevated tank or reservoir. Streams can be small for a [spot-size] fire, or of a powerful penetrating nature for large, [running] fires . . . ." (NFPA, 1951). As a basis for a water attack in these several effective, varied forms, a "Second Fire Triangle" has been suggested (Strain, 1964).



WATER "IN THE RIGHT FORM" involves the heat-absorbing capability of water. "Vaporization of water results in the production of steam in a ratio of 1 to over 1,600. Perfection in the use of water as a fire extinguishing agent would be achieved if water could be applied in a form and at a rate whereby the entire volume would be converted to steam" (Layman, 1955). This is impossible in forestry operation. Foglike patterns may be effective in fast-burning cheat grass but impractical in chamisal stands. A large straight-stream may be necessary to reach fire in a burning snag but very wasteful on a crowning brush field. Wet water may be most useful during fire mopup. Under certain conditions sprays may be of value.

"Wet" water, "thick" water, "heavy" water, "light" water and "thin" water are some of the more common terms related to the forms of water. Water treated with either approved chemicals or foam also has its place and requires special equipment for use.

WATER "IN THE RIGHT PLACE" involves effective, uninterrupted water application at the base of a hot, moving or spotting fireline in adverse forest fuel types. "Water must reach the burning material itself, and impinge on the burning surface, cooling it to a point where it no longer glows, nor continues to emit flammable gases" (NFPA, 1953). The involved and exposed forest combustibles must be cooled to a temperature below 300°F.

WATER "IN THE RIGHT AMOUNT" is still another factor. Several simple, structural firefighting rules are helpful:

- A gallon of water is required to extinguish 1 pound of burning class A material (Strain, 1964).
- A gallon of water is vaporized by 9,338 BTU's (Strain, 1964).
- A $\frac{1}{2}$ inch tip is generally sufficient to give a volume which will kill the usual residence fire (NFPA, 1953).

The "Second Triangle" - whose three sides are the right form, the right place, and the right amount - forms a sound basis for water handling equipment selection; and herein is the purpose of this GUIDE.

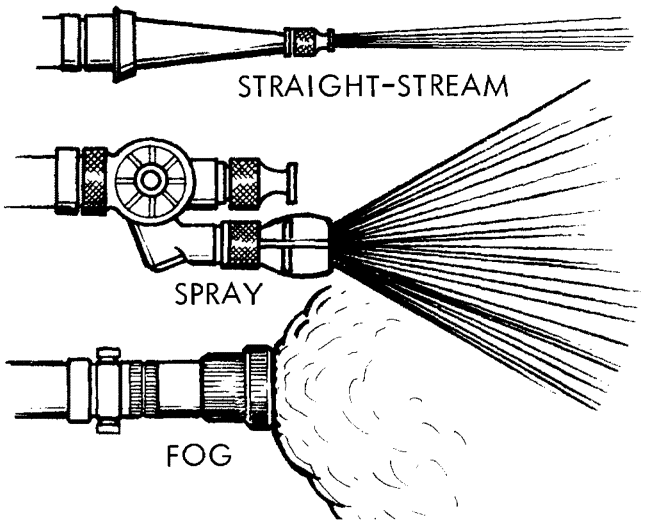
THE ABC'S OF SELECTION

1.1 - THE ABC's of fitting and outfitting a selected tanker or pumper for your fire job can be found in this GUIDE:

A - SELECT THE RIGHT NOZZLE

(See section 5)

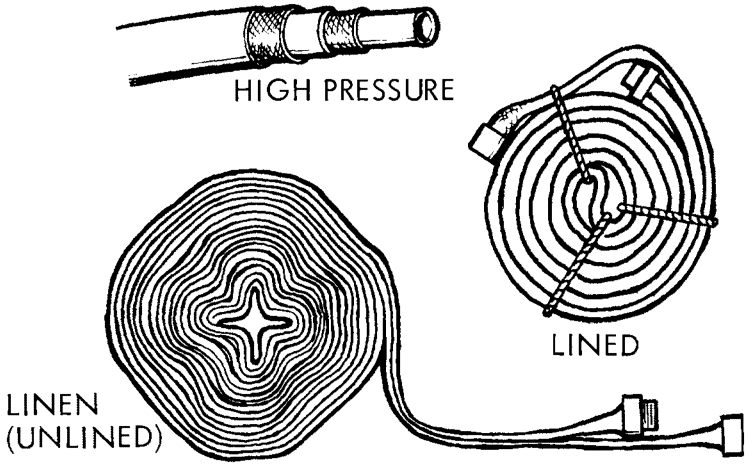
. . . Lever or barrel shutoff, weight, finish, cost, etc.



B - SELECT THE RIGHT HOSE

(See section 4)

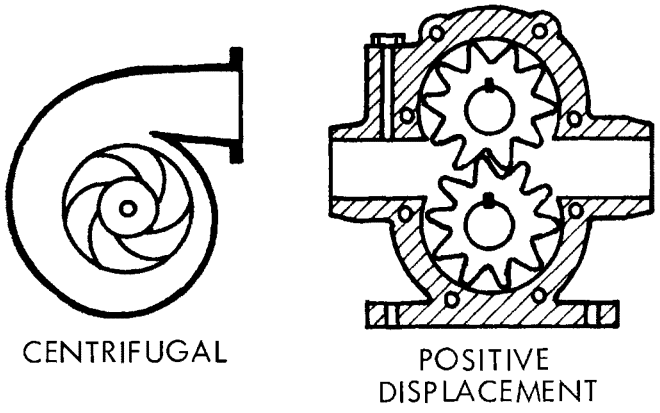
. . . ID (waterway), length of sections, weight, type of materials, cost, etc.



C - SELECT THE RIGHT PUMP

(See section 3)

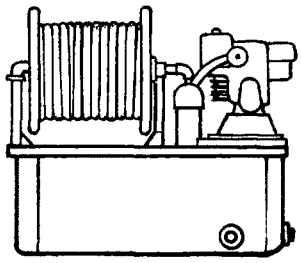
. . . Performance, GPM @ PSI, driven by engine or vehicle, weight, cost, etc.



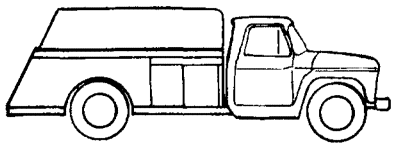
D - SELECT THE RIGHT TANKER

(See section 2)

. . . Model number, tank size, metal or plastic, reel or basket, weight, cost, etc.



SLIP-ON



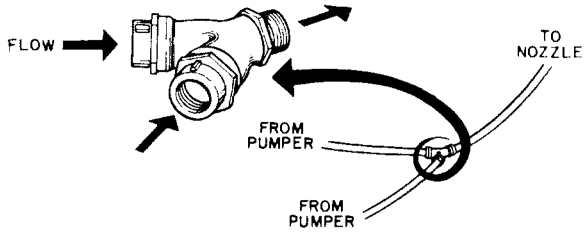
PTO

E - SELECT THE RIGHT FITTINGS AND CONNECTIONS

(See section 4)

F - SELECT THE RIGHT ACCESSORIES

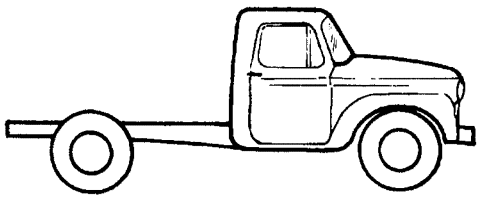
(See section 7)



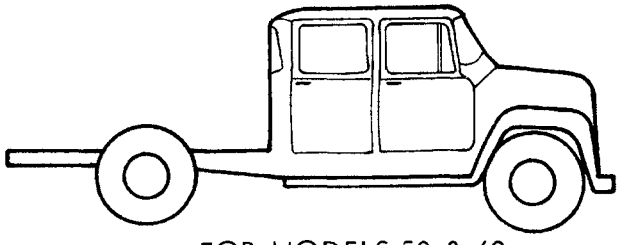
G - SELECT THE RIGHT VEHICLE

(See page 2.0--2 and your FS Equipment Management Representative.)

. . . 4 x 2 or 4 x 4, GVW, horsepower, seating, springs, tire rating, vehicle accessories, cost, etc.



FOR MODELS 10, 20, 30 & 40



FOR MODELS 50 & 60

DEFINITIONS

ABRASION - "The grinding or wearing away of a solid surface by abrasive materials, such as slurries and dirty water." (NFPA - Chemicals Hdbk., 1967).

ANGLE OF DEPARTURE - The angle between the road surface and the line drawn from the rear point of ground contact of the rear tire to any sprung projection of the truck behind the rear axle. (NFPA - Fire Terminology, 1961)

BACK PRESSURE - See PRESSURE

BAFFLE - A partioned wall placed in water tanks to reduce shifting of the water load when starting, stopping, or turning. NFPA specifies at least one "swash" portion; also, that no compartment volume exceed 100 gallons.

CENTRIFUGAL PUMP - A centrifugal pump employs outward force from a center of rotation to move or impel water. It is usually larger in design and is employed for higher volume and power pressure. Generally, it does not require pressure relief valves except for extremely high pressures. Berkeley, Hale, and Darley pumps fall in this class. Centrifugal pumps generally are not as efficient as positive displacement pumps. Gallon for gallon, a centrifugal pump usually requires more horsepower.

CENTRIFUGAL PUMP, Single-stage - "The single-stage pump has one single impeller. For rated capacities through 750 gpm, the impeller is usually the single-suction type . . . . The output of the single-stage pump, both volume and pressure, is controlled directly by the engine throttle setting, making it the simplest type of centrifugal pump to control. Each centrifugal pump will have a point of maximum volume which is determined by the pump design, power available, and suction or supply conditions. There is also a 'cut-off' . . . for fire service centrifugal pumps . . . (which) is approximately 450 psi . . . ." (NFPA Hdbk., 1967). The Hale CBPD on the Model 60 and the Gorman-Rupp 02F1-GR used on the Model 40 are examples of single-stage centrifugal pumps in Forest Service use.

CHANGE ORDER - A written authorization by a Forest Service contractor's representative to substitute another component or part or to change the size, arrangement, or location in a final product.

CHASSIS - For the purposes of this GUIDE, the chassis consists of a complete automotive vehicle, including cab but without body.

CHEMICALS, FOREST FIRE FIGHTING - See retardant.

CODING, PUMPER - See section 3.0--8.

CURB WEIGHT - "Weight of the truck empty (without payload and driver) but ready to drive, including a full fuel tank, cooling system, and crankcase; tools, spare wheel, and all other equipment specified as standard." (Hildy's Bluebook, 1967)

CYCLES - Two-stroke-cycle engines require two strokes to complete a power cycle consisting of a power stroke and a compression stroke. Four-stroke-cycle engines require four strokes to complete a power cycle consisting of intake, compression, power, and exhaust strokes. Commonly referred to as 2-cycle and 4-cycle.

DENSITY ALTITUDE - Pressure altitude corrected for temperature.

DRIVE WHEELS - Trucks are referred to as 4x2's, 4x4's, etc. The first figure indicates the number of wheels on the ground and the second figure, the number of driving wheels. Dual tires on the rear are considered as a single wheel.

EJECTOR - See section 6.6.

ENGINE - The unit used to furnish mechanical power to drive a fire pump.

EROSION - "The act of eroding or wearing away surfaces from the impingement of chemical slurries and solutions which contain abrasive materials." (NFPA - Chemicals Hdbk., 1967)

FITTINGS - See section 6.

FOAM - "A chemical fire-extinguishing mixture. When applied, it forms bubbles which greatly increase the mixture volume. It adheres to the fuel and reduces combustion by cooling and moistening and by excluding oxygen." (FSH 5125.3, p. 70-14)

FRICTION LOSS - The resistance resulting as water moves along the inside wall of either fire hose or pipe. Hence, we usually speak of "friction loss" in psi per 100 feet of hose between a pump (or hydrant) and the nozzle.

GEAR RATIO - "The number of teeth on the driven gear divided by the number of teeth on the driving gear. Total reduction is the multiplication of gear ratios, such as rear axle ratio times transmission first gear ratio." (Hildy's Bluebook, 1967)

HAMMER, WATER - "The shock force exerted when the flow is stopped by closing a valve is known as water hammer . . . as in the case of water flowing through pipe or hose. "The force of water hammer is, in some cases, sufficient to rupture pipe or hose lines. To avoid this danger it is recognized practice to proceed slowly when operating valves on water lines." (Fyr-Fyter, 1961)

HEAD - "Pressure due to elevation of water sometimes termed 'back pressure' by firefighters, amounting to 0.433 lbs. per ft. of elevation. A 100 ft. elevation of a water storage level will give 43.3 lbs. static head . . . ." This is true regardless of the diameter. As a rule of thumb, we say it takes $\frac{1}{2}$ psi to lift water 1 foot in elevation. (NFPA - Fire Terminology, 1961)

HIGBEE CUT - "The first or outside thread of a hose coupling or nipple is removed to prevent crossing or mutilation of threads." (NFPA - Fire Terminology, 1961)

HOSE LAY - "The arrangement of connected lengths of fire hose and accessories on the ground, beginning at the first pumping unit and ending at the point of water delivery . . . ." (FSH 5125.3, pp. 70-17).

HORSEPOWER - "A measure of an engine's work capacity . . . . One hp is equivalent to 33,000 foot-pounds of work per minute. Gross hp is the power of the basic engine - without generator, water, pump, fan, etc. (at a specific rpm) . . . . Net hp is the usable power output of an engine 'as installed' - the gross hp minus the hp used to drive the . . . accessories at a specified rpm."(Hildy's Bluebook, 1967)

IMPELLER - The rotating part of a centrifugal pump which imparts energy to the water to be moved.

IMPINGE - "To project one stream into another or a high velocity stream against a metal wall, or lining of a pipe, or fitting. Much of the erosive wear found when soft brass fittings are used in high pressure retardant lines is due to impingement against gates, sharp turns, and protruding surfaces." (NFPA - Chemicals Hdbk., 1967)

KILL SWITCH - Switch in an automatic kill feature assembly to shut down a pumper or vehicle-driven PTO when the unit runs out of water, thereby preventing pump damage.

LIMITED STANDARD - Tankers, pumpers, and related equipment which is inspected and maintained and in active service. The specification and construction drawings are no longer maintained, and replacement in kind is not available.

MODEL - Indicates a design to assist in identification of the particular FS tanker. For example: Model 10 is the 50-Gallon Metal Slip-on Tanker updated in 1964.

NONSTANDARD - "Devices, equipment , and methods not meeting fire protection standards such as those recommended by the NFPA . . . . For example, fire hose coupling threads which will not attach to hose or devices having American National Standard Fire Hose Threads." (NFPA - Fire Terminology, 1961)

OBSOLETE - No longer current; out of date and should be replaced.

OUTPUT, MAXIMUM - Defined as a maximum flow for a given pressure without exceeding the safe speed established by the engine manufacturer and with 5 inches of mercury vacuum at pump inlet.

POSITIVE DISPLACEMENT PUMPS pass or move a definite quantity of water with each stroke or revolution of the impeller. The rotary, gear, cam, and piston self-priming pumps are typical units. Most of these pumps are subject to abrasive damage and require relief valves to handle line surges, overloads, and flows not needed at the nozzle. They are generally preferred for constant-flow, high-pressure applications. Examples: Pacific Pumper WX-10, Edwards L-23, and Eco-Western Fire 14x120A.

POWER TAKE-OFF - "On the transmission or transfer case that can be used to deliver engine power to auxiliary equipment" such as a water pump. (Hildy's Bluebook, 1967)

PROGRESSIVE HOSE LAY - "Hose lay used in forest and brush fires in which double-gated wyes are inserted in the main line ($1\frac{1}{2}$") at intervals and lateral lines are run from the wyes to the fire, thus permitting continuous application of water during extension of the lay." (NFPA - Fire Terminology, 1961)

PUMPER - Combination of a fire pump and a related engine. As defined and used in this GUIDE, does not include the water tank and its related structure.

PUMPER, Portable - a pumper which can be carried by one to four men to a source of water pumping directly to the fire through various lengths and combinations of hose lines. Both two- and four-cycle gasoline engines are used.

PUMPER, Portable, Lightweight - a portable pumper weighing 60 pounds or less which can be backpacked by one man.

QUALIFIED RATING - The pressure and flow which can be maintained continuously by the pumper with 5 inches of mercury vacuum at the inlet of the pump.

RETARDANT - "A fire retardant (chemicals) is any substance that by chemical or physical action reduces or inhibits flammability of combustibles. The rate of spread or the flame front is thereby slowed or retarded." (NFPA - Chemicals Hdbk., 1967) FIRE FIGHTING)

SELECTED FLOW - Refers to the continuous rated flow of the pump (or pumper) as selected for the 100-hour endurance test conducted by San Dimas Equipment Development Center.

SELECTED PRESSURE - Refers to the continuous rated pressure of the pump (or pumpers) as selected for the 100-hour endurance test conducted by San Dimas Equipment Development Center.

SELECTED RATING - Refers to the combination of selected pressure at selected flow as rated for the 100-hour endurance test conducted by San Dimas Equipment Development Center.

SIAMESE - See section 6.13.

SINGLE-STAGE - See centrifugal pump, single-stage.

SLIP-ON - Consists primarily of a water tank, live hose reel or basket, and an auxiliary pump and engine, all combined into a single slip-on tanker. The slip-on is carried on any pickup or flatbed-type truck of adequate length and capacity and is easily installed and removed. Examples: Forest Service Models 10, 20, 30, and 50.

STANDARDS - (Forest Service) - Refers to tankers, reels, threads, accessories, etc., which have been formally designed to established criteria, tested, accepted, and currently maintained for Service-wide or Regional use by the Division of Fire Control. Standard Forest Service equipment is described by a numbered specification and is usually accompanied by detailed drawings for construction and/or bid.

STANDARDS - (NFPA) - "Standards of the National Fire Protection Association frequently adopted by insurance agencies such as the National Board of Fire Underwriters as a basis for their regulations and used as a guide for Municipal, State, or provincial laws, ordinances, and regulations . . . . " (NFPA - Fire Terminology, 1961)

SUPPRESSANT - "An agent used to extinguish the flaming and glowing phases of combustion by direct application to the burning fuel." Water used in this manner is a suppressant (NFPA - Chemicals Hdbk., 1967).

SURGE - A rapid increase in flow which may result in an attendant pressure rise. (See HAMMER, WATER, also.)

TANDEM - "Basically one behind another . . . . With pumpers it is used as a relay operation with short lines between pumps. In some cases a pumper at a hydrant supplies a second pumper either through a short discharge line or by connection suction inlets of the two pumps by a length of suction hose . . . . For example; if 400 psi discharge pressure is needed, two pumps could be used in tandem with each pump adding 200 pounds to the discharge pressure . . . . " (NFPA - Fire Terminology, 1961)

TANKER - Consists of a vehicle equipped with tank, pump, and necessary tools and equipment for work on grass, brush, and timber fires. The fire pump may be driven as a power take-off from the vehicle engine or by an auxiliary engine. It may consist of a slip-on mounted on a conventional truck bed or a permanent unit of integral design.

TANKER BOSS - "A person in a fire suppression organization responsible to the sector boss for supervising usually 3 to 5 tanker units to get efficient and productive use of water in either direct attack or mopup work on fires." (FSH 5125.3, p. 70-29)

TEST, 100-HOUR - A formal 100-hour endurance test conducted in the hydraulic laboratory at San Dimas Equipment Development Center to establish a qualified Products List under Forest Service Specification 273a, Engine Driven Pumpers, and Specification 274, Lightweight Portable Pumpers.

WETTING AGENT - "A chemical additive used to modify the characteristics of water used for firefighting. It reduces surface tension, permitting better dispersal and greater penetration. In some respects, the action is similar to familiar detergents which make water wetter. Water to which a wetting agent has been introduced is called 'wet water.'" (NFPA - Chemicals Hdbk., 1967)

WET WATER - Water treated with chemicals to increase the spreading and penetrating properties. The chemical additive is referred to as a "wetting agent."

WHEELBASE - "The distance from the centerline of the front axle to centerline of the rear axle."

WYE - See section 6.18.

ABBREVIATIONS

1.3 - ABBREVIATIONS. The following abbreviations were largely derived from the Government Printing Office STYLE MANUAL and the NFPA FIRE PROTECTION HANDBOOK.

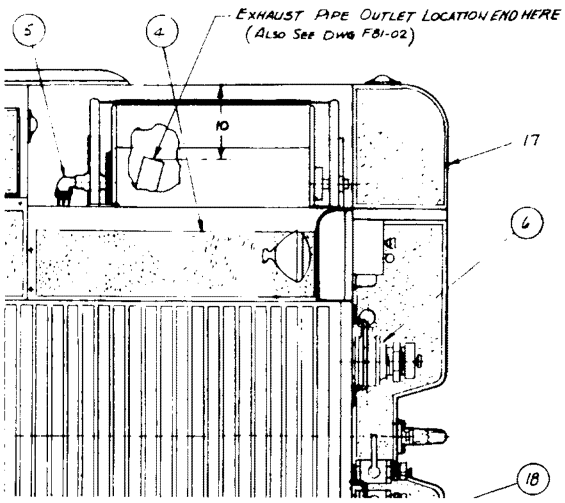
C	-	centrifugal
CA	-	cab-to-axle
CJRL	-	cotton jacket rubber-lined (fire hose)
CW	-	curb weight of unladen vehicle (with conventional body)
deg.	-	degree(s)
DJRL	-	double jacket rubber-lined (fire hose)
EP	-	engine pressure (pressure at the pumper or tanker)
F	-	Fahrenheit
FL	-	friction loss
FM	-	Factory Mutual Engineering Division
FS	-	Forest Service (U.S. Department of Agriculture)
FSN	-	Federal stock number (General Services Administration)
ft.	-	foot (feet)
gal.	-	gallon(s)
G.H.T.	-	garden hose thread
gpm	-	gallons per minute
GSA	-	General Services Administration
GVW	-	gross vehicle weight
H	-	hydrant
hp	-	horsepower
ID	-	inside diameter
in.	-	inch(es)
I.P.T.	-	iron pipe thread
LPG	-	liquid petroleum gas
mph	-	miles per hour
NBFU	-	National Board of Fire Underwriters
NBS	-	National Bureau of Standards
NFPA	-	National Fire Protection Association
NH	-	American National fire-hose coupling thread (for garden, chemical, and fire protection hose)

ABBREVIATIONS (Continued)

No., Nos.	-	number(s)
NP	-	nozzle pressure
NPSH	-	American National hose-coupling threads (straight pipe threads for hose couplings and nipples)
N.P.T.	-	American Standard taper pipe threads
N.S.T.	-	National Standard Threads
OD	-	outside diameter
P or PD	-	positive displacement
PL	-	payload (GVW-CW)
psi	-	pounds per square inch
psig	-	pounds per square inch gauge
PTO	-	power take-off
QPL	-	qualified products list
R-1, etc.	-	Region One, Forest Service, USDA
rpm	-	revolutions per minute
SDEDC	-	San Dimas Equipment Development Center
SJRL	-	single jacket rubber-lined (fire hose)
T.P.I.	-	threads per inch
UL	-	Underwriters' Laboratories
USDA	-	U.S. Department of Agriculture

TANKERS

2.0 - TANKER SURVEY. A Service-wide inventory in 1964 showed that about 1,650 tankers, with tank sizes varying from 50 to 1,400 gallons, were in use on the National Forests. Of this total, 1,500 were slip-on units with comparatively low performance rates. A number of the smaller slip-ons have been built from FS drawings; but a substantial percentage, especially in the larger sizes, had been provided from various sources and were lacking in standardization. Visits to the Forests indicated that, all too often, good hydraulic engineering design was lacking. At the same time several Regions were providing standardization with the 50-Gallon Slip-on Patrol, the Three-Compartment Slip-on, and the Models 2 and 3, One-Compartment Slip-ons.



STANDARDIZATION. The 1964-1970 standardization program has resulted in a wide selection of models. The Forest Service has six standard tanker models. Tank capacities range from a 50-gallon patrol size to a 500-gallon crew size. Several models and sizes are stocked by West Coast fire suppliers. Specifications and detailed drawings are maintained at SDEDC. They are available for all models for contract or agency shop construction.

There are 194 individual 28"x40" sheets covering the models described in this section and maintained by SDEDC.

ADDITIVES. The 1964 survey and project direction given indicate that plain water will usually be used for these ground tanker systems. Liquid phosphates, like "11-37-0" (NFPA - Chemicals Hdbk., pp. 20-21, 1967) could be added on the fireline and used in Models 30 and 50, with certain modifications and precautions.

Foams can be produced with the Model 50 and 60 Tankers by using a carefully selected "in-line" eductor and a mechanical protein-type foam (FS - Equip Tips, 1963). This is a rather involved operation, and FS crews are not encouraged to provide such service except for special arrangements.

The Model 50 Tanker can be modified under options to provide viscous water (NFPA - Chemicals Hdbk., 1967). However, little interest has been shown in thick water. Phos-Chek 259 might also be used in FS tankers, with certain provisions and limitations.

Wetting agents[1/] can be added at the fire, in all tankers except Model 10 and those slip-ons using a Briggs-Eco Pumper. All metal tanks constructed to FS specifications have been treated with a hot-dip galvanize coating which is affected by some wetting agents. After wet water has been used, the tank and pump should be thoroughly flushed out. Wetting agents should not be held in metal tanks.

TRUCKS. Formal evaluation statements and field surveys indicate that many FS trucks and tanker slip-ons or integral bodies are mismatched. Overloading was the general rule. This resulted not only from the original truck selection but from adding on superfluous tools, equipment, and gear. Only agency enforcement can correct this problem. Nominal GVW loadings have been suggested, but this GUIDE assumes that careful direction in this area will be spelled out by Equipment Management.

OBJECTIVES. The following design objectives offer reasonable choices for FS purchase:

- Selection of pumpers with increased hydraulic performance
- Selection of various tank sizes
- Selection of three different tank materials
- Interchange of tank, pumpers, reel or basket, and other major components
- Simplification of design and operation
- Standardization, with improved operator performance
- Protection (safety devices)
- Correction of errors by "fail-safe" devices
- Correlation of payloads with truck capabilities
- Competition among suppliers and fabricators

1/ Wetting agents for FS use are evaluated by the Forest Fire Laboratory, Macon, Georgia. A list of acceptable products is issued by the Director, Division of Fire Control, Washington, D.C. (See FSM 516.23.)

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MODELS & OPTIONS. Following are the six standard models. Tank capacities range from 50 through 500 gallons. A wide selection of pump performance is available:

SUMMARY OF SLIP-ON MODELS

TANKER:	Model 10	Model 20	Model 30	Model 50
-Standard	Service-wide	Service-wide	Service-wide	Service-wide
-Type	Slip-on	Slip-on	Slip-on	Slip-on
-Pump mounting	Top	End	Top	End
-Kill feature	Yes	Yes	Optional	Yes
-Color	Green or red	Green or red	Green or red	Green or red
TANK:				
-Capacity (gals.)	50	75, 125, 200	75, 125, 200	300
-Material	Metal	Metal	Plastic	Metal
TANKER PERFORMANCE:				
-Minimum	7 gpm @ 150 psi	15 gpm @ 200 psi	Optional	50 gpm @ 200 psi
TRUCK: 4x2				
-GVW	5.0	6,700, 7,800 & 8,500	6,700, 7,800, &8,500	16,000
-Bed	Mfr.	Mfr. or silhouette	Mfr. or silhouette	Mfr.
-Men (No.)	1	1 or 2	1 or 2	2 to 5
LIVE HOSE:	Reel	Reel or basket	Reel	Reel
SUPPRESSANTS:				
-Chemical	No	No	Yes	Yes
-Foams	No	No	No	Yes
-Viscous water	No	No	No	Yes
-Wetting agent	No	Yes	Yes	Yes

SUMMARY OF CALIFORNIA REGION POWER TAKE-OFF MODELS

TANKER:	Model 40	Model 60
-Standard	R-5	R-5
-Type	Integral	Integral
-Pump mounting	PTO	PTO (Flywheel)
-Kill feature	Yes	Yes
-Color	Green	Green
TANK:		
-Capacity (gals.)	75, 125, 200	500
-Material	Metal	Metal
TANKER PERFORMANCE:	70 gpm @ 200 psi	175 gpm @ 400 psi
TRUCK:		
-GVW	6,500, 7,300, &8,200*	22,500
-Bed	Silhouette	Fabricated
-Men (No.)	1 or 2	6
LIVE HOSE:	Basket	Two reels
SUPPRESSANTS:		
-Chemical	No	No
-Foams	Yes	Yes
-Viscous water	No	No
-Wetting agent	Yes	Yes

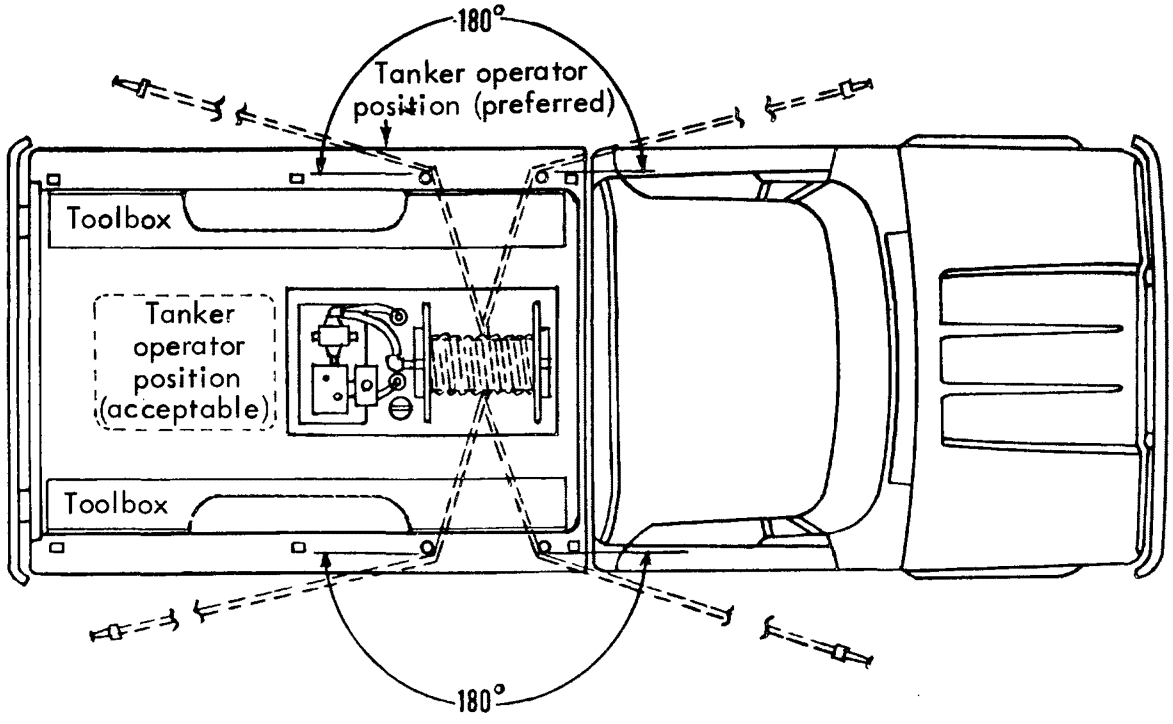
*For 4x2's, see detailed write-up for more specific information.

METAL SLIP-ON CONSTRUCTION

Model 10 . . . . . 50-Gallon Tank
Model 20 . . . . . 75-, 125-, & 200-Gallon Tank
Model 50 . . . . . 300-Gallon Tank

2.1 - DESIGN CONSIDERATIONS. The Model 10 and 20 Slip-on Tankers incorporate the following design considerations:

- Are used for one- or two-man attack units.
- Provide simple, single hose lays of 3/4" or 1" ID, 200' to 400' in length; 1" I.P. hose thread will be used.
- Offer a simple "load and bolt-down" concept.
- Establish two tanker operator positions - a preferred position on the ground on the driver's side, with all controls within arm's reach. Establish a second operator position in the truck bed for top-mounted assemblies.
- Pump from "tank to fire," "draft to fire," and "draft to tank."
- Place reel in back of the cab and parallel to the truck bed, thus providing a 180-degree sweep with the hose line from both sides.
- Limit tank width to 47" and height to 22". The 50-gallon tank is smaller.
- Emphasize simplicity.
- Keep the costs down.



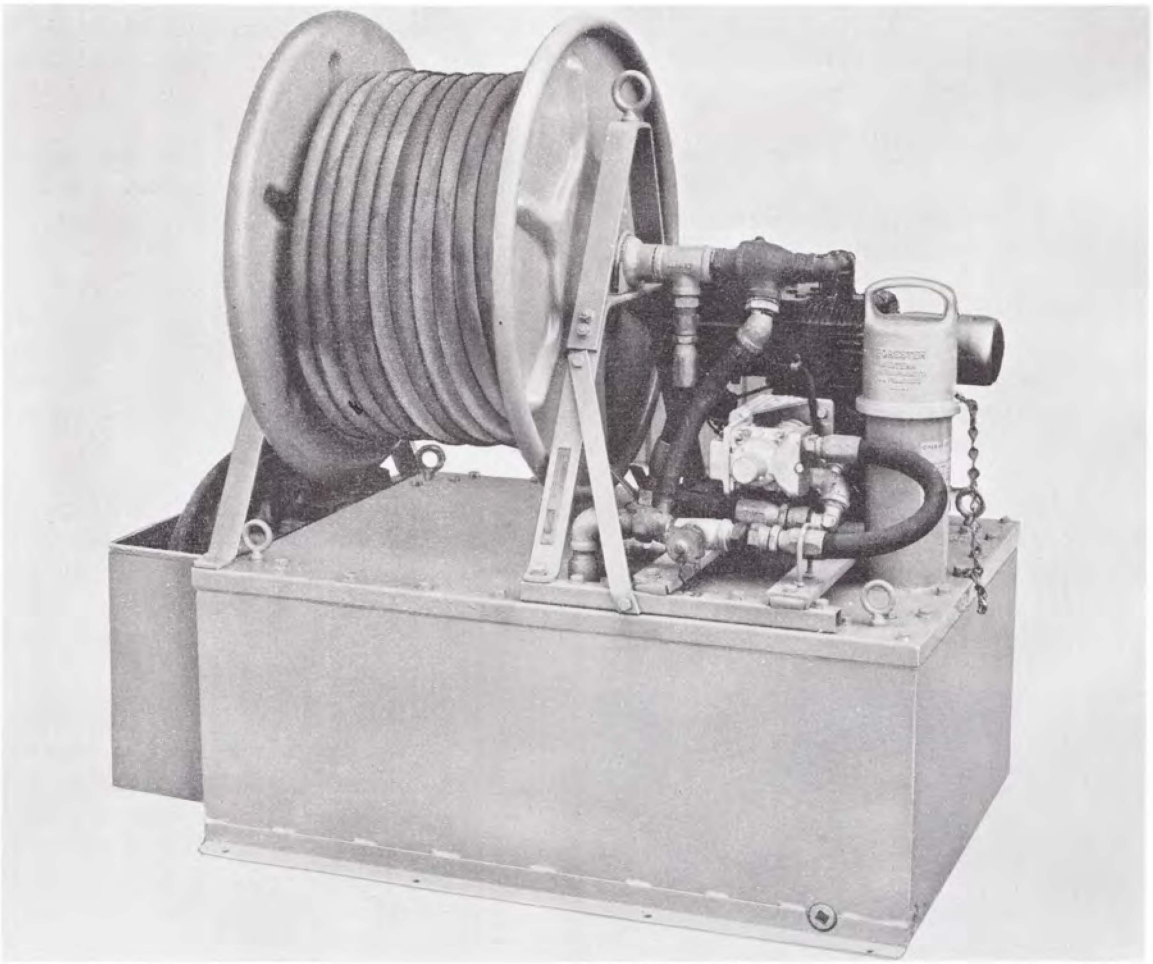
INTERCHANGEABILITY. Metal tanks and reels constructed to FS drawings and specifications are interchangeable between the Models 20 and 40. These tanks are a standard width and vary only in length and height (see page 2.1.2--1). The same tank filler cap will fit all Model 10, 20, 30, and 40 Tankers.

Stainless steel tank fabrication can be substituted for mild steel, but the cost is higher.

MODEL 50. The text in section 2.1 has been primarily concerned with Model 10 and 20 descriptions. Since there is only one description of one tank size for the Model 50, details are covered specifically in section 2.1.3.

MODEL 10 SLIP-ON TANKER

Tank Size:	50-gallon
Crew Size:	1-man
Pumper Performance:	7½ gpm @125 psi
Style:	Top-mounted; all-metal construction
Standard:	Service-wide use; USDA - Forest Service



2.1.2 - GENERAL. This is a "mini" patrol tanker carrying 50 gallons of water for initial attack on small, slow-moving fires and for mopup use. If a low volume of water, as from a garden-type nozzle, would be effective, this unit could be considered. It is the lowest priced model in the slip-on series and will mount in a 5000 GVW pickup.

This tanker offers a low silhouette slip-on consisting of a small live hose reel and an engine-driven pumper mounted on a low rectangular baffled tank.

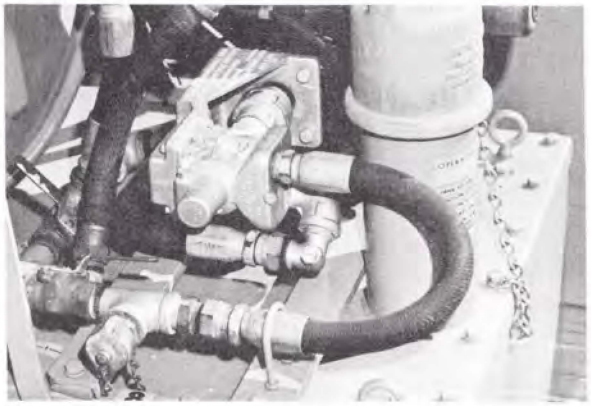
SLIP-ON WEIGHT AND DIMENSION. The dry weight of the slip-on is 395 pounds; filled with water, 830 pounds. The overall measurements of the unit are: $26\frac{1}{2}$" wide x 43" long x 41" high. A metal tie-down flange is provided on each side of the tank.

TANK DESCRIPTION. The 50-gallon steel tank base is 24" x 36", and the height is 14". A full-top opening is provided for good tank access. The tank interior is galvanize-coated for protection. A 4-inch filler opening is provided with a standard lightweight metal cap.

REEL AND HOSE. A live hose reel is equipped with 200' of 3/4" ID rubber-lined, rubber-covered, high-pressure hose. The hard line is equipped with a nozzle with a 1" I.P. Thread base, a shutoff, and six straight streams and six fog streams. (See Forester "Six Shooter" Nozzle, Western Fire Catalog #4A785.) We do not recommend the use of garden hose.

Those Regions using this slip-on as a flamethrower unit or with diesel-base sprays may prefer to equip the reel with 5/8" ID oil-resistant industrial hose. (See description of multifunctional uses on page 2.1.1--4.)

COLOR OPTIONS. . . . . Green or Red



PUMP. The Eco Model 251D is mounted on its side to provide drainage. Compound 107 impellers are now specified for all orders so these new units can handle special work assignments involving diesel oil. This inexpensive positive displacement pump can be readily replaced.

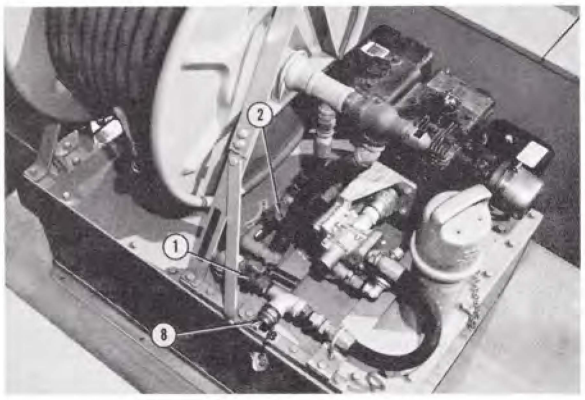
ENGINE. The pump is powered by a 3 hp Briggs & Stratton 4-cycle gasoline engine, Model 80332. The Forest Service requires the rewind starter rope to be mounted in a twelve o'clock position to avoid hand injuries with the air cleaner. A self-starter is not provided with this slip-on. A qualified spark arrester (Gill 3C1P) is specified.

PUMPER. The Briggs-Eco engine-pumper combination is rated at:

PSI	50	100	150
GPM	11	11	10

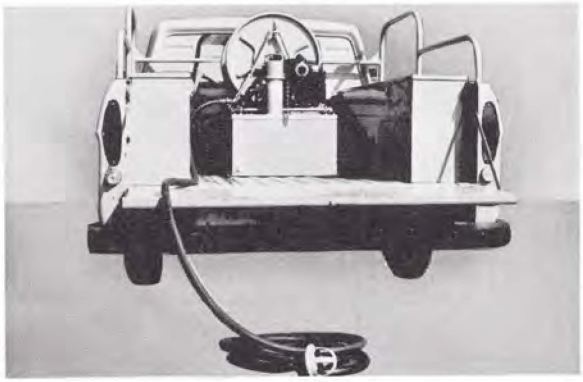
The pumper coding designation is P-045-15/08 ("Performance Codings," section 3.0). Actual field performance through the plumbing will be around $7\frac{1}{2}$ gpm @ 125 psi. The actual dry weight of the pumper only is 42 pounds. A "kill feature" is provided to stop the engine when the unit is emptied.

PLUMBING. This tanker can pump from tank to fire, draft to fire, or draft to tank. Two in-line valves (#1 & #2, in photo) and a draft connection hose cap (#8) control these basic operations. A carefully selected relief valve insures full flow up to the selected bypass pressure.



The plumbing can be drained easily by removing hose cap #8, opening the two in-line valves, and rotating the pump with the starter. This feature will minimize winter damage to plumbing.

DRAFTING. One 25' length of 3/4" ID high-pressure hose is carried for drafting assignments. One-inch I.P. Thread with rocker lug couplings is used on this hose with a 1" suction strainer. A metal suction hose bucket is usually ordered but is listed as optional equipment. (See photo, page 1.)



MULTI-USES. Design changes and careful accessory selection provide other uses for this basic slip-on. Compound 107 impellers and oilproof-type hose and connections make it possible to pump diesel fuels for flamethrower use. This is a separate development and will be described separately.

Tests show that most wetting agents will damage the pump impellers in this unit. This tanker is not capable of handling thickened retardants designed for airtanker use, such as Fire-trol 100 and Phos-chek 202.

Oil base sprays such as 2,4-D and 2,4,5-T can be pumped under certain limitations for weed control work.

WRITTEN MATERIALS. The Equipment Development Center, 444 E. Bonita Avenue, San Dimas, California 91773, is serving as custodian for the following current written materials:

1. Specification 5100-346, 50-GALLON SLIP-ON TANKER (Model 10)
2. Construction Drawings F72-01 through F72-05
3. INSTRUCTIONS FOR OPERATION AND CARE OF THE 50-GALLON SLIP-ON TANKER

AVAILABILITY. The Regional Administrative Office of the California Region (5) has been issuing annual construction bids about September 1. Delivery is made the following spring or summer. Other Regions and other Federal agencies have procured tankers through R-5.

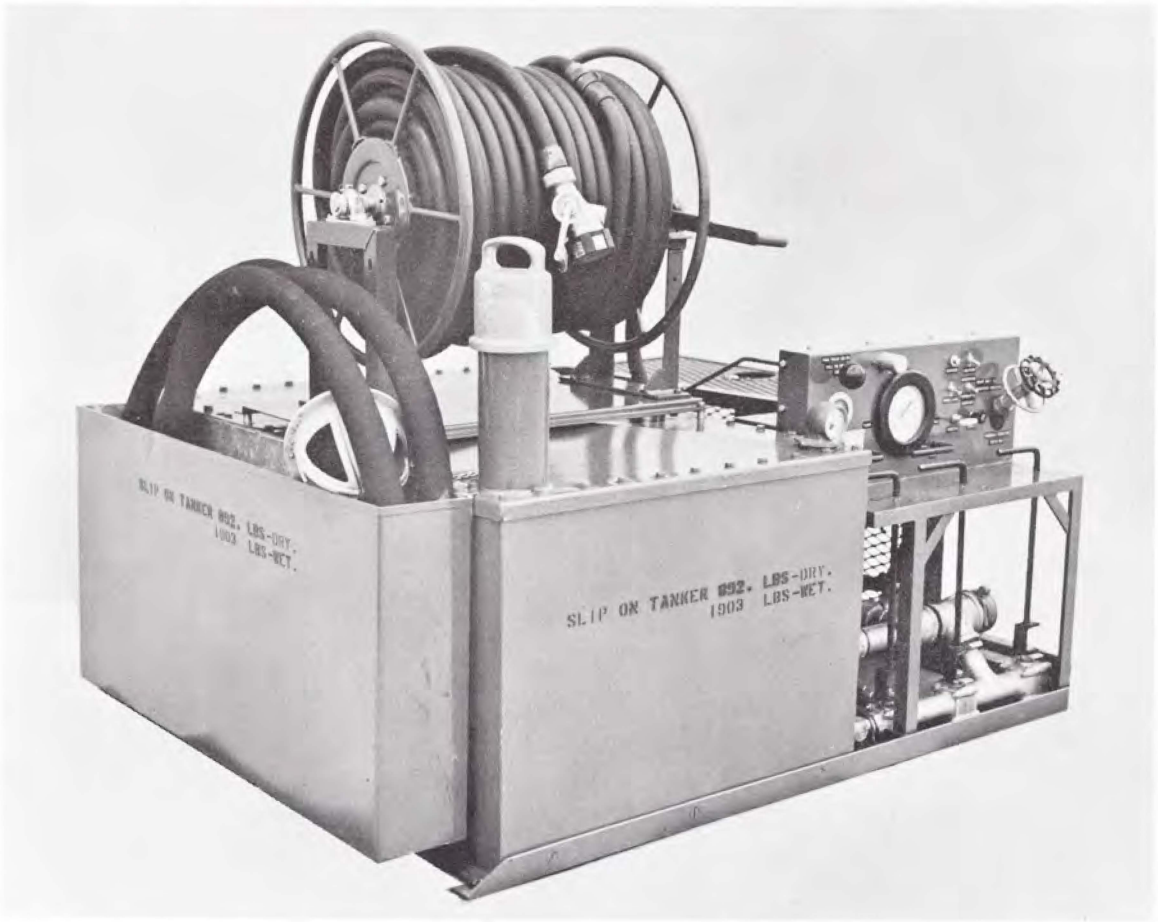
At least one West Coast fire supply company carries this slip-on in stock for open market purchase. (See Western Fire Equipment Company Catalog #14x400A.)

FITTINGS AND FIRE HOSE FOR MODEL 10 TANKERS

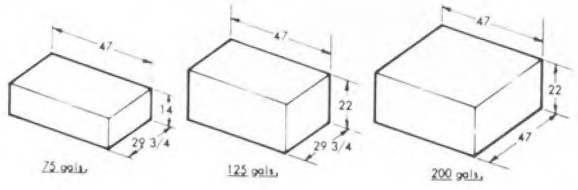
Description	Federal Stock No.	Quantity
GASKET (Washer) for Hose Coupling Swivel (FS Spec. 102):		
For 3/4" size	5330-599-0776	3
For 1" size (1-1/16" to 1-7/16")	5330-720-2621	5
For 1½" size (1-9/16" to 2")	5330-239-1873	2
HOSE, Fire, High-Pressure, Rubber 3/4" ID x 25'; Rocker Lug Couplings with 1" I.P. Thread (for suction hose)	-	1
HOSE, Fire, High-Pressure 3/4" ID x 50'; Rocker Lug Couplings with 1" I.P. Thread (FS Spec. 185)	4720-595-1838	4
INCREASER, 3/4" Female G.H. Thread to 1" Male I.P. Thread	-	1
KIT, Pumper Maintenance, includes the following:		
Canvas pocket pouch	-	1
Engine operation and maintenance instructions	-	1
Engine parts list (Briggs & Stratton Model 80332)	-	1
Gauge, feeler, spark plug	5210-189-9538	1
Instructions for Operation and Care of the 50-Gallon Model 10 Metal Slip-on Tanker	-	1
Pump parts list	-	1
Rope, starter	-	1
Spark plug, Champion J-8 or equal	2920-540-8342	1
Wrench, spark plug, 13/16"	-	1
NOZZLE, Forester "Six Shooter" (Western Fire catalog No. 4A785) 6 Straight-stream and 6 Fog Patterns with lever shutoff	-	1
REDUCER (Adapter), 1" Female I.P. Thread to 3/4" Male G.H. Thread	-	1

MODEL 20 SLIP-ON TANKER

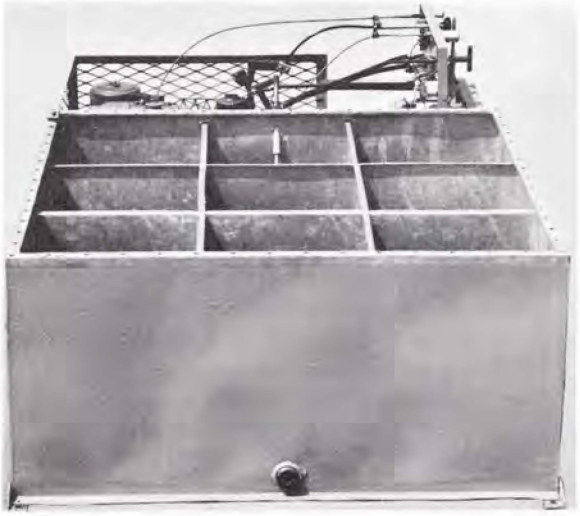
Tank Sizes: . . . . . 75-, 125-, and 200-gallon
Crew Size: . . . . . 1- or 2-man
Pumper Performance: . . . . 15 gpm @ 200 psi minimum or optional specified pumper coding
Style: . . . . . End-mounted; all-metal construction
Standard: . . . . . Service-wide use: USDA - Forest Service



2.1.2 - GENERAL. The Model 20 slip-on is available in three different tank sizes, 75-, 125-, and 200-gallon. All three tanks are 47 inches wide but vary in height and length. The overall slip-on will slide down a standard 49-inch pickup bed aisle, and six bolts secure the slip-on to the bed of the vehicle. Only the tank dimensions and slip-on frame length vary; all other dimensions and features remain identical in the three sizes. One cable connection to the truck battery completes the installation.



TANK DESCRIPTION. 14-gauge welded sheet-metal construction. Full tank top access. 4" ID lightweight filler spout cap. Hot-dip galvanize tank coating. 1-1/2" N.P. Thread plumbing connection.



REEL OR HOSE BASKET OPTION (METAL CONSTRUCTION)

Reel capacity (using 3/4" ID high-pressure rubber hose) . . . . . 250 ft.
Hose basket (using 1" cotton-synthetic jacket-lined) . . . . . 200 ft.

COLOR OPTIONS . . . . . Green or Red

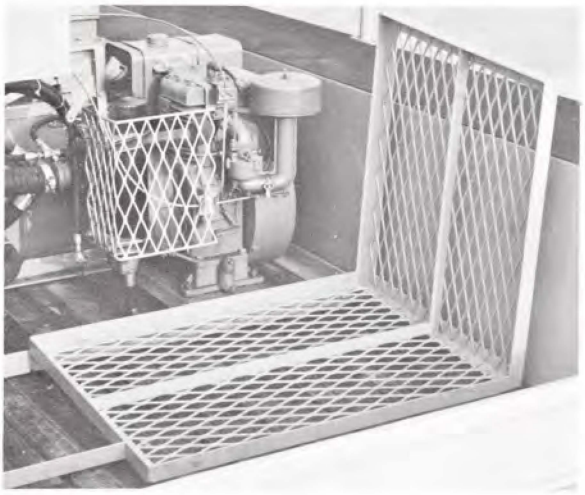
PUMPER PERFORMANCE OPTION (AT PUMP DISCHARGE)

Make and Model	Coding	Weight	Performance (GPM under PSI) 50	100	150	200	250	300	425
Berkeley B1-1/2XQBS-10	C-175-15/35	196	52	44	35	18	--		
Cedco A10F	P-130-40/08	124	--	10	10	10	10	10	10
Cedco or Hale HPZZ	C-175-20/15	171	60	30	20	15	--		
Edwards L-23	P-175-20/25	154	49	47	37	28	--		
Pacific WA-7	P-130-25/15	135	26	25	24	21	17		
Pacific WX-10	P-175-20/20	170	45	43	32	24	--		

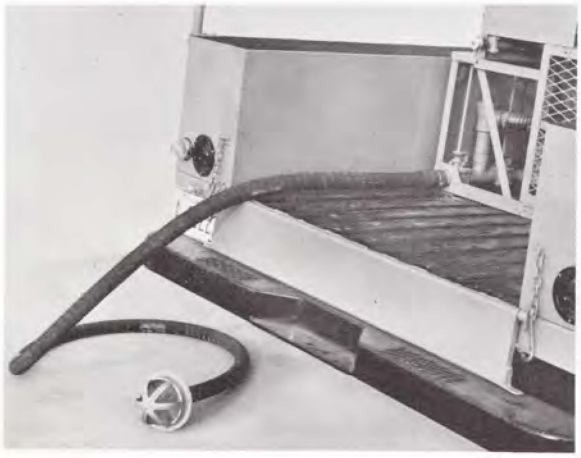
The engine-driven pumpers selected all have four-cycle engines and use regular gasoline without oil additives. Other qualified engine-driven pumpers could be plumbed into this end-mounted system. Electric starters are recommended and are connected to the vehicle by cables.

Symbol "C" in the Code column stands for centrifugal pumps and "P" for positive displacement pumps. (See section 3, "Summary of Advantages and Disadvantages of Centrifugal and Positive Displacement Pumps" and "Performance Codings."

Flows given in the performance table were measured at the discharge connection of the pump, but this performance is reduced slightly through the tanker's plumbing system.



PUMPER MOUNTING. Adequate space is provided for the installation of various qualified pumpers, as shown in the photo. The pumpers plumbed to date are described under an earlier paragraph "Pumper Performance Option..."



The suction hose is attached at a low point in the plumbing in the pickup bed. This low position provides about 2 feet of added lift over top-mounted assemblies.

A submerged shutoff valve in the tank will retain a full tank of water after plumbing and pump have been drained.

SUCTION HOSE BUCKET. Metal buckets are provided for suction hose as an option. They are attached at the forward end of the slip-on between the tank and the vehicle cab. The buckets are 6" x 42" overall. The 125- and 200-gallon sizes are 20" in depth, and the 75-gallon is 12".

AVAILABILITY. The Regional Administrative Office of the California Region (5) has been issuing annual construction bids about September 1. Delivery is usually made the following spring or summer. Other Regions and other Federal agencies have been procuring tankers through R-5.

Construction costs vary from year to year. The 200-gallon size costs little more than the 75-gallon slip-on.

WRITTEN MATERIALS. Specification(s) and construction drawings for the Model 20 are available to all Government agencies. A charge will be made for construction drawing prints for non-Governmental requests. The Equipment Development Center, 444 E. Bonita Avenue, San Dimas, California 91773, is custodian for the following written materials:

1. Interim Specification 5100-00347, SLIP-ON TANKER, METAL, END-MOUNTED, CAPACITY 75-, 125-, and 200-GALLON (MODEL 20).

2. Construction Drawings F73-01 through F73-12 and F73-14 through F73-16; 75-, 125-, and 200-GALLON SLIP-ON TANKER WITH CENTRIFUGAL OR POSITIVE DISPLACEMENT PUMPER.

3. Construction Drawings F71-01 through F71-08; "TANK ASSEMBLY DRAWINGS . . . "

4. OPERATION AND CARE OF THE 75-, 125-, and 200-GALLON MODEL 20 SLIP-ON TANKERS WITH CENTRIFUGAL PUMPERS.

5. OPERATION AND CARE OF THE 75-, 125-, and 200-GALLON MODEL 20 SLIP-ON TANKERS WITH POSITIVE DISPLACEMENT PUMPERS.

6. FOREST SERVICE DATA SHEET FOR ENGINE-DRIVEN PUMPER (Specify make and model.)

The following described models are in a "limited" service category and specifications and drawings for them are no longer maintained.

1. Medium Three-Compartment Slip-on Tanker
   Size #1: 60/160-gallon tank
   Size #2: 75/200-gallon tank

2. Medium One-Compartment Slip-on Tanker
   Model 2: 75/175-gallon tank
   Model 3: 175/200-gallon tank

FITTINGS AND FIRE HOSE FOR MODEL 20 TANKERS

(WITH CENTRIFUGAL PUMPER)

Description	Federal Stock No.	Quantity
CLAMP, Shutoff, Pocket-Size; for 1" and 1-1/2" SJ or Linen Hose	4210-767-7123	1
COUPLING, Hose, Rocker Lug, Double Female, 1" I.P. Thread	None	1
COUPLING, Hose, Rocker Lug, Double Male, 1" I.P. Thread	None	1
EJECTOR, Hydraulic, Including Foot Valve and Strainer, Penberthy 65A*	None	1
GASKET (Washer) for Hose Coupling Swivel (FS Spec. 102)		
For 3/4" size (13/16" to 1-7/16")	5330-599-0776	10
For 1" size (1-1/16" to 1-7/16")	5330-720-2621	10
For 1-1/2" size (1-9/16" to 2")	5330-239-1873	5
For 2-1/2" size (2-9/16" to 3-1/4")	5330-239-1877	3
HOSE, Fire, High-Pressure, Rubber, 3/4" ID x 50'; Rocker Lug Couplings with 1" I.P. Thread (FS Spec. 185)	4720-595-1838	4**
HOSE, Single JRL, 1" ID x 100'; Rocker Lug Couplings with 1" I.P. Thread (FS Spec. 5100-00186)	4210-777-1591	3***
HOSE, Single JRL, 1-1/2" ID x 100'; Rocker Lug Couplings with 1-1/2" N.S. Thread	4210-777-1592	1
HOSE, Suction, Rubber, 1-1/2" ID x 8'; Rocker Lug Couplings with 1-1/2" N.S. Thread (FS Spec. 184)	4210-889-1774	3
INCREASER, 3/4" Female G.H. Thread to 1" Male I.P. Thread	None	1
INCREASER, 1" Female I.P. Thread to 1-1/2" Male N.S. Thread	None	1

*This basic list is for the Cedco (Hale) HPZZ and the Pacific WA-7. Use Penberthy 64A for Berkeley 1-1/2 x QBX-10, Edwards L-23 and Pacific WX-10. Use Penberthy 62A for the Cedco AIDF.

**When unit is equipped with hose basket, reduce quantity to zero.

***When unit is equipped with hose basket, increase quantity to 5.

FITTINGS AND FIRE HOSE FOR MODEL 20 TANKERS (Cont'd)
(WITH CENTRIFUGAL PUMPERS)

Description	Federal Stock No.	Quantity
KIT, Pumper Maintenance, includes the following:		
Engine Operation & Maintenance Instructions	None	1
Engine Parts List	None	1
Gauge, Feeler, Spark Plug	5210-189-9538	1
Instructions for Operation and Care of the 75-,125-, and 200-Gallon Model 20 End-Mounted Metal Slip-On Tanker with Centrifugal Pump*	None	1
Pump Parts List	None	1
Rope, Starter	None	1
Spark Plug, Champion J8 or equal **	2920-540-8342 **	1
Wrench, Spark Plug, 13/16"	None	1
NOZZLE, Fire Hose, Fog and Solid-Stream Combination: 1" I.P. Thread Base (R-5 Spec.). Complete with four tips: 3/16" Straight-Stream (4210-203-3855) 3/8" Straight Stream (4210-203-3845) #3 Fog, 2-4 GPM (4210-204-3358) #6 Fog, 5-7 GPM (4210-204-3386)	4210-640-1892	1
NOZZLE, Forester "Six Shooter" (Western Fire catalog No. 4A785) 6 Straight-Stream and 6 Fog Patterns with level shutoff	-	1
NOZZLE TIP, 1/8" Solid-Stream, 3/4" G.H. Thread (FS Spec. 5100-00244)	None	1
NOZZLE TIP, 1/4" Solid-Stream, 3/4" G.H. Thread (FS Spec. 5100-00244)	None	1
REDUCER (Adapter), Rocker Lug, 1" Female I.P. Thread to 3/4" Male G.H. Thread	None	1
REDUCER (Adapter), Rocker Lug, 1-1/2" Female N.S. Thread to 1" Male I.P. Thread (F.S. Spec. 104)	4210-975-2969	2
STRAINER, Suction, Fire Hose, Globe-Shaped, 1-1/2" Female N.S. Thread (FS Spec. 5100-00105)	4210-984-3460	1
WRENCH, Spanner, 1" and 1-1/2" Combination (FS Spec. 5100-101)	5120-596-1426	1
WYE, Two-Way, Gated, 1" I.P. Thread	None	1

*Order separate Instructions for positive displacement pumpers.
**For the Edwards L-23 use Champion J-8, Autolite A-7, or equal (2920-540-8342) For WA-7 and WX-10 use Champion D-16, Autolite BT-8, or equal (2920-540-8352).

MODEL 21 SLIP-ON TANKER

Tank Sizes: . . . . . 125-, and 200-gallon
Crew Size: . . . . . 1- or 2-man
Pumper Performance: . . . 15 gpm @ 200 psi minimum or optional specified pumper coding
Style: . . . . . End-mounted; all-metal construction
Standard: . . . . . Service-wide use: USDA - Forest Service

GENERAL. The Model 21 slip-on is available in two different sizes, 125- and 200-gallon. Both tanks have been narrowed to 41 in. to accomodate dual rear wheels and are 22 in. high. The 125-gallon tanker assembly is 63¼ in. long and the 200-gallon is 84¼ in. long. The general layout follows the design of the Model 20 shown on page 2.1.2--1.

CONTROLS. The pump and engine controls, tank filler cap, nozzle, and reel release are within arm's reach on one panel. The fireman stands on the ground for the "tank to fire" operation. Access to the 1-in. overboard discharge and the 1½-in. suction hose connection is from the vehicle bed.

ELECTRICAL SYSTEM. A self-contained electrical system has been provided as an option in the Model 21. The electric starter for the pumper can be driven by either the vehicle battery or by a self-contained battery, depending upon the need. A rope starter can be used in an emergency.

SLIP-ON DIMENSIONS (INCHES OVERALL)

Tank Size	Slip-on Unit with Reel			Tank Only		
	Width	Length	Height	Width	Length	Height
125	41	62¼	48¼	40½	36	22
200	41	84¼	48¼	40½	57	22

SLIP-ON WEIGHTS (LBS) WITH REEL (NO HOSE) AND WITH REPRESENTATIVE PUMPER (Design Estimates).

Tank Size	Slip-on Dry	Slip-on Wet	Suggested Truck (GVW)	
			4x2	4x4
125	820	1,860	7,800	8,400
200	910	2,477	8,500	9,250

TANK DESCRIPTION. Welded sheet-metal construction of 14-gauge is used throughout. The tank is fully baffled. Full tank-top access is provided. A standard 4-in. ID filler spout cap is provided. A hot-dip galvanized coating is used inside and out. N.P. thread plumbing connections of $1\frac{1}{2}$-in. are used.

REEL. Reel capacity (using 3/4-in. ID high-pressure hose) -- 250 ft.
A hose basket is not available for this model.

COLOR OPTIONS. Green or red.

PUMPER PERFORMANCE OPTION (AT PUMP DISCHARGE)

Make and Model	Coding	Weight	Performance (GPM under PSI) 50	100	150	200
Berkeley B1-1/2XQBS-10	C-175-15/35	196	52	44	35	18
Cedco HPZZ (Hale 15 FC-B23)	C-175-20/15	171	60	30	30	15

The engine-driven pumpers selected all have four-cycle engines and use regular gasoline without oil additives. Other qualified engine-driven pumpers could be plumbed into this end-mounted system.

Symbol "C" in the Code column stands for centrifugal pumps. (See section 3, "Summary of Advantages and Disadvantages of Centrifugal and Positive Displacement Pumps" and "Performance Codings."

Flows given in the performance table were measured at the discharge connection of the pump, but these flows are reduced slightly through the tanker's plumbing system.

BATTERY OPTION. A self-contained battery has been provided as an option in the Model 21, but the pumper can be started and driven on the vehicle battery. Electric starters are recommended in every case and are included in the design.

PLUMBING. As in the Model 20, the suction hose is attached at a low point in the pickup bed. This low connection provides about 2 ft. of added lift over top-mounted assemblies such as the Model 30. This design also permits easy draining for freeze protection.

A shut-off valve just outside the tank will retain a full water load after the plumbing and pump have been drained. This will maintain the tanker in a ready condition during moderate freezing weather.

AVAILABILITY. The Regional office of the California Region (R-5) issues annual construction bids about October 1. Delivery is usually made the following spring or summer.

Construction costs vary from year to year, with both sizes usually costing about the same.

WRITTEN MATERIALS. Specifications and construction for the Model 21 are available to all Government agencies.

A charge will be made for construction drawing prints for non-Governmental requests. The Equipment Development Center, 444 East Bonita Avenue, San Dimas, California 91773, is custodian for the following written materials:

1. Interim Specification for SLIP-ON TANKER, METAL, END-MOUNTED, CAPACITY 125- and 200-GALLON (MODEL 21).

2. Construction Drawings Series F85 125- and 200-GALLON SLIP-ON TANKER WITH CENTRIFUGAL PUMPER.

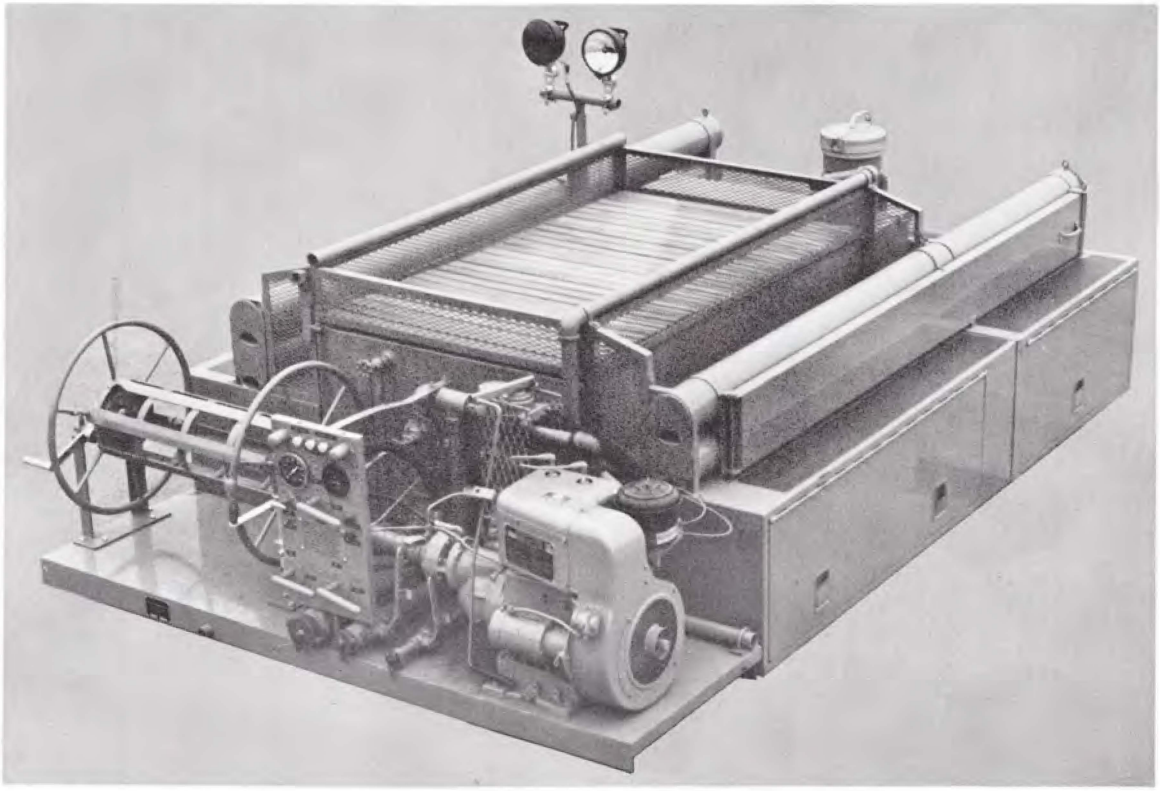
3. OPERATION AND CARE OF THE 75-, 125-, and 200-GALLON MODEL 20 (and MODEL 21) SLIP-ON TANKERS WITH CENTRIFUGAL PUMPERS.

4. FOREST SERVICE DATA SHEET FOR ENGINE-DRIVEN PUMPER (Specify make and model.)

FITTINGS AND FIRE HOSE. See the Model 20 list on pages 2.1.2--6 and --7.

MODEL 50 SLIP-ON CREW TANKER

Tank Size:	300-gallon
Crew Size:	5- or 6-man
Pumper Performance:	50 gpm @ 200 psi
Style:	End-mounted; all-metal construction
Standard:	California Region; USDA - Forest Service



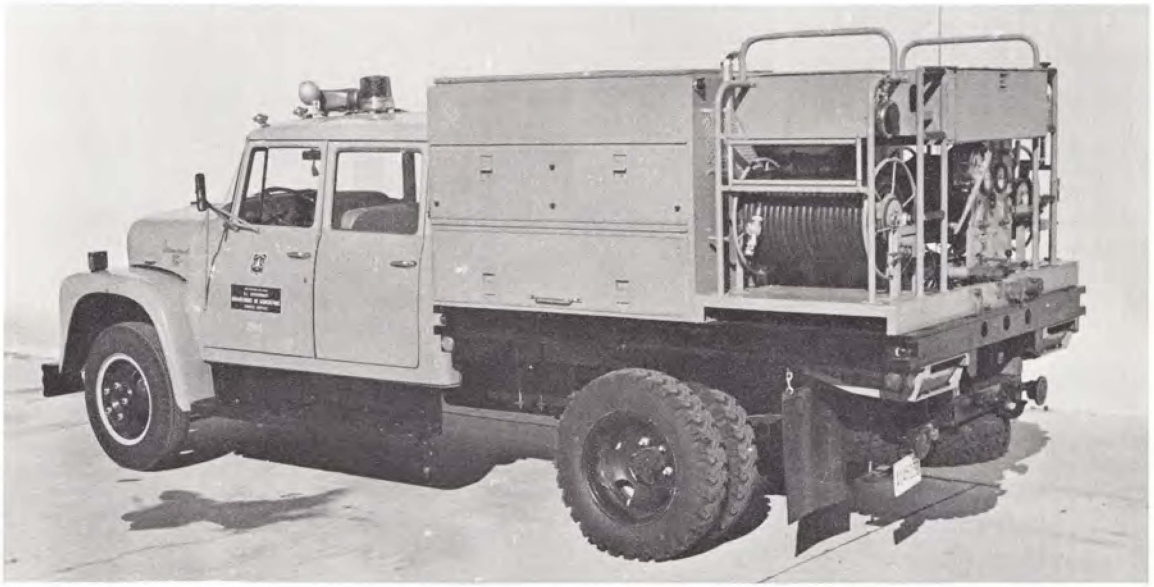
2.1.3 - GENERAL. This model slip-on tanker is used in fire suppression and on prescribed burns and large right-of-way burning and clearing jobs. It has been designed to slide onto the 12-foot stake body of a 16,000 GVW truck and be readily removable when the vehicle is needed for other purposes. It provides a compact truck-mounted unit for crew transport, a 300-gallon water supply with pumping facilities, and a full complement of necessary tools and equipment. The tanker operates mainly on unimproved mountain roads, which subject the unit to high stresses, vibration, and other related operational treatment. It was designed for a 12-year useful life.

The 300-gallon rectangular tank has one compartment fully baffled. Numerous storage compartments have been provided for fire tools, water fittings and accessories, and hose. One hose reel is mounted on the rear deck. A crew seat is provided in the forward section of the slip-on behind the cab. The engine-driven centrifugal pumper is capable of delivering at least 50 gallons per minute at 200 psi. This pumper assembly, plus the necessary plumbing hookup and control panel, is mounted on a base frame to form an integral unit. The slip-on will accommodate engine-driven pumpers up to and including the 400-pound weight class.

The USDA Forest Service uses about ninety 300-gallon slip-ons in the California Region. Other Federal agencies have purchased a significant number during the past decade. This unit will continue to serve a real need in the low-cost field.

MODEL 51 SLIP-ON CREW TANKER

Tank Size (Nominal):	300-Gallon
Crew Size:	6-man
Standard:	Service-wide; USDA-Forest Service
Style:	Slip-on, end-mounted, all-metal construction
Tanker Performance:	50 gpm @ 200 psi
Pump:	Engine-driven, single-stage, centrifugal
Throttle (pumper):	Manually set with kill-feature



GENERAL. These truck-mounted slip-on units are designed for operation on mountain roads and in off-road assignments along moving firelines. The slip-on is designed for abnormal stresses, vibration, and other rough operational fire work.

The slip-on mounts on the 9- or 12-foot stake bed of a 16,500 GVW, or larger, truck and is removable for truck exchange. Certain modifications are recommended for the truck itself, including a second battery, mirrors, clearance lights, reflectors, vapor-lock resistant fuel system, rear deck steps, red light and siren.

The 300-gallon tank is plumbed to an engine-driven single-stage centrifugal pump having a minimum performance capability of 50 gpm at 200 psi. Pumper controls are arranged at the back of the tanker.

The top hose compartment provides adequate space for 1" and $1\frac{1}{2}$" lined fire hose. Two live hose reels are included. A full complement of hand-tools is carried in dustproof metal compartments.

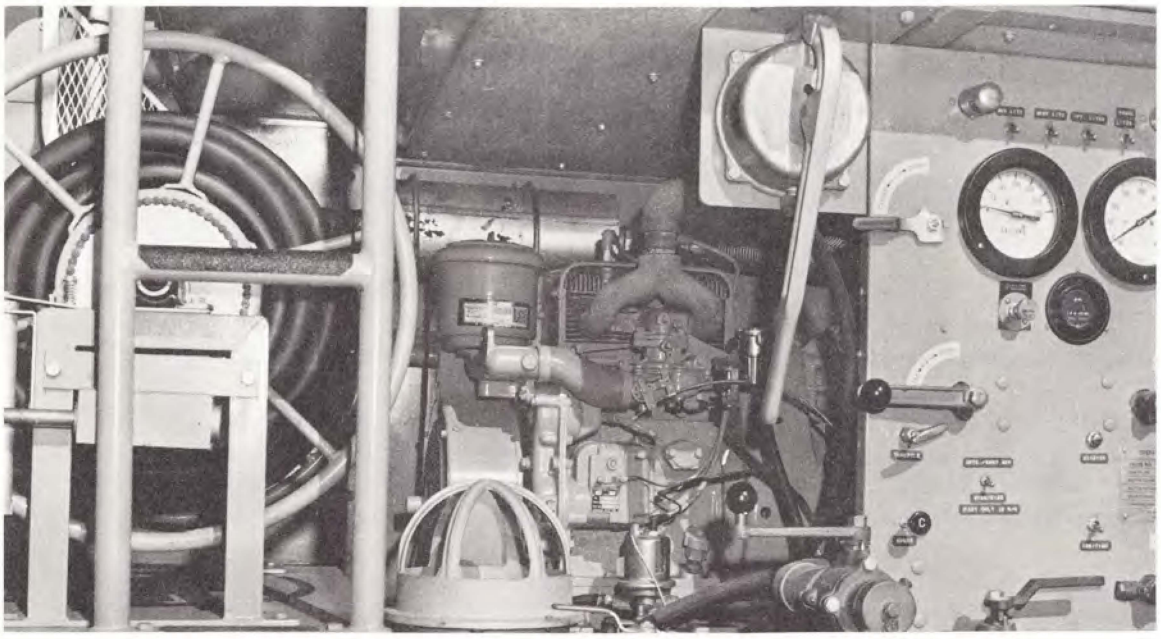
The four-door commercial cab of the truck accomodates a crew of six men in two seats. If a one-seat truck is used, a longer bed can be used with an exterior crew seat located behind the truck cab.

PUMPER PERFORMANCES (AT PUMP DISCHARGE). The engine-driven pumpers qualified for Forest Service use on the Model 51 Tanker all have four-cycle engines and use regular gasoline without oil additives. Other qualified engine-driven centrifugal pumpers could be plumbed into this end-mounted system. Electric starters are used on all pumpers and use power from the truck battery.

Flows given in the performance table were measured at the discharge connection of the pump, but this performance is reduced slightly through the tanker plumbing system.

Make and Model	Coding	Weight*	50	100	150	200	250
CEDCO HPZF (THD)	C-400-20/50	303	87	87	77	58	37
CEDCO HPZZ (TJD)	C-300-25/25	269	65	65	62	62	26
Berkeley B 1½XQBS-18	C-400-20/70	330	122	114	96	70	39

*The weights given are without starters. Additional detail about these pumpers is included in Section 3.3.1.



A manual priming pump is provided on the instrument panel at the rear of the truck.

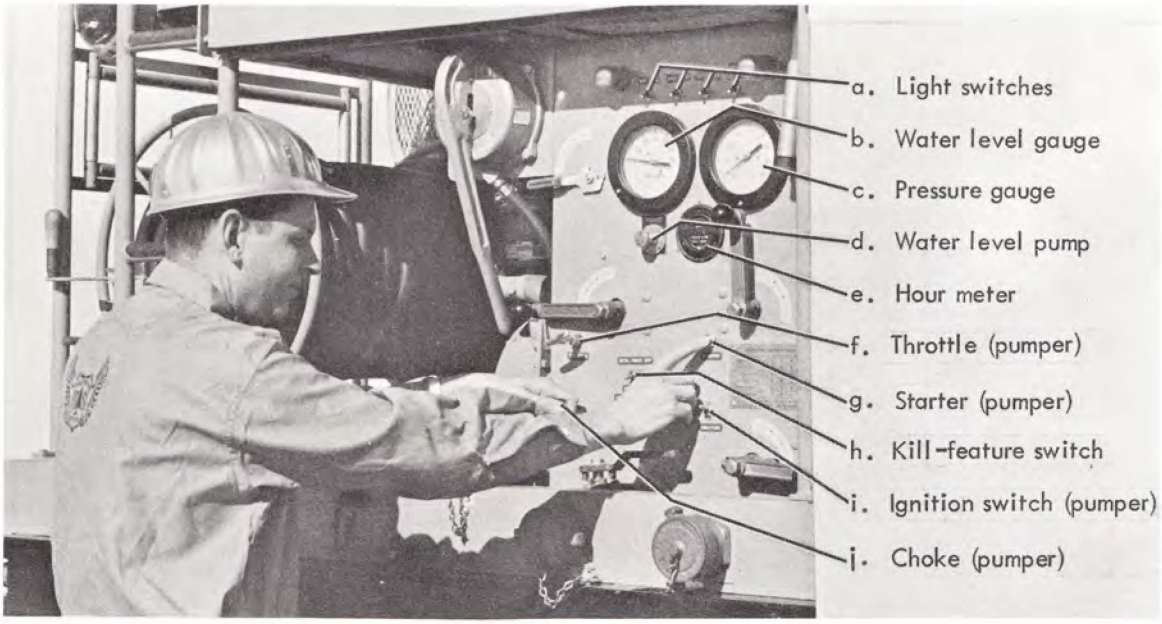
The gasoline for the pump engine is supplied from the vehicle gas tank.

TANK. The 300-gallon welded tank is constructed of 12-gauge sheet metal. The tank is rectangular with a flat bottom. The dimensions are 41" wide x 61" long x 31" high. Two-hundred and ninety-five gallons of usable water can be pumped from the tank. The interior and exterior of the tank are coated with hot-dip galvanize to reduce corrosion. If prevention from freezing is required for a short period, a full tank of water can be held with dry plumbing and pump.

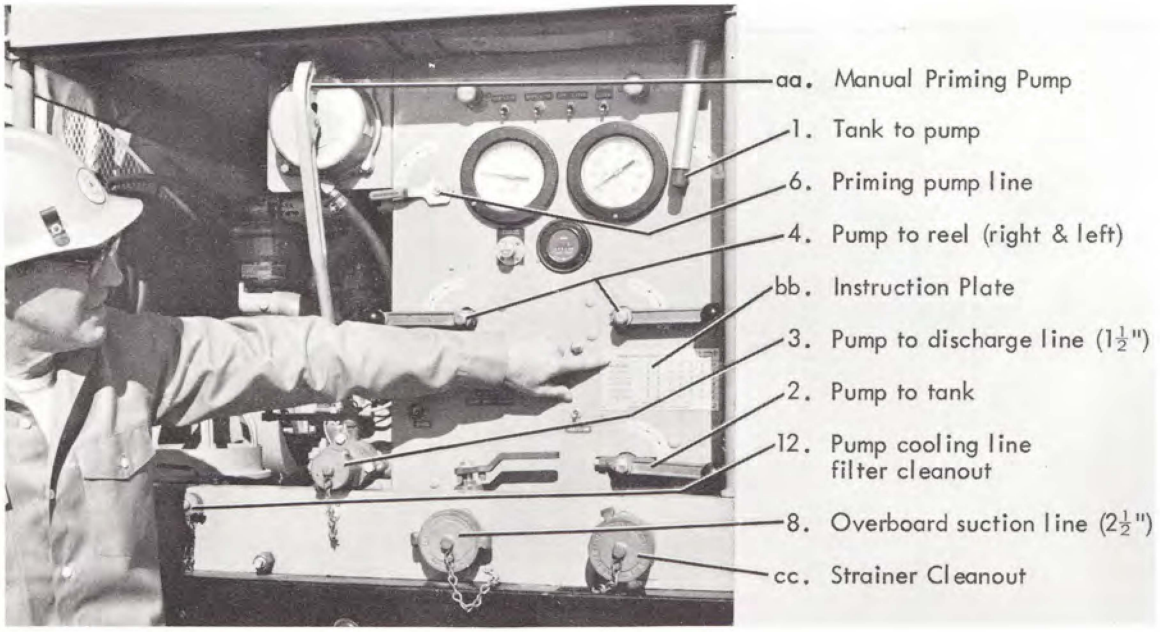
The tank filler spout is about $6\frac{1}{2}$" inside diameter and is equipped with a plastic strainer. The $1\frac{1}{2}$" refilling line from the pump is routed to the top of the tank. A $1\frac{1}{2}$" overflow line drains on the curb side by the rear wheel. The tank is plumbed for a 2" connection to the pump inlet.

The tank is fully baffled to prevent sloshing. Access is provided by a removable full tank top opening.

OPERATOR'S PANEL. The truck controls are in the cab and all pumper and hydraulic controls are located at the rear of the tanker. An instrument panel 20" wide and 27" high is positioned at shoulder height for easy access. The primary features are:



VALVE CONTROLS. In addition to the tanker controls already mentioned under "OPERATOR'S PANEL" are the following standard "VALVE CONTROLS" for tanker operation.


aa. Manual Priming Pump
1. Tank to pump
6. Priming pump line
4. Pump to reel (right & left)
bb. Instruction Plate
3. Pump to discharge line (1½")
2. Pump to tank
12. Pump cooling line filter cleanout
8. Overboard suction line (2½")
cc. Strainer Cleanout

REELS. Two 250' live reels are provided at the rear of the truck - one on each side. 3/4" inside diameter high-pressure rubber fire hose is used (see Fire Hose and Fittings List for Model 51.) A hose roller guide assembly allows the live hose to be pulled in any direction without difficulty. A manual crank rewind is provided.

TRUCK MODIFICATIONS. The following modifications are made to the standard chassis:

1. Batteries. Provide two 12-volt, 70 amp-hour batteries connected in parallel with a selection switch.
2. Seat belts. (One for each passenger with metal to metal type buckle. May be provided under truck specification.)
3. Fuel system. Vapor-lock resistant.
4. Siren. (In accordance with Regional policy.)
5. Rear steps. (For access to tanker body and compartments.)
6. Stepped fuel tanks. Provide additional gasoline for truck and the engine-driven pumper which is tied into the truck's fuel system. Recommended a minimum size of 50 gallons (may be provided in truck purchase).

CHASSIS OPTIONS. The Model 51 prototype slip-on was placed in service on a truck with a 6-man crew cab and a 9-foot stake bed. This cab provides all-weather protection and roll-over safety features required by certain Regions. Other Regions or agencies with small crews may prefer 3-man cabs. A crew seat can be installed facing forward in back of the cab on a 12-foot stake bed. The slip-on must be carefully positioned on the bed to provide proper loading on the front and rear wheels. Bed heights in certain truck models may create a problem of excess height above ground level. (See "Chassis Description" for certain options involving batteries, gas tanks, etc.)

SERVICE LIFE. The tanker body is constructed of formed sheet metal and should have a useful life of 14 years or more. The first prototype unit was constructed in 1970 and placed in service in 1971. The centrifugal pumpers selected for this assignment have good service records. The adoption of the Model 51 tanker places the earlier Model 50 in a "limited" standard category.

AVAILABILITY. The Regional Administrative Office of the California Region (R-5) usually receives annual construction bids in September. Other Regions and Federal agencies may place orders through R-5, or they may handle their own contract construction. However, this will require rather involved COR and inspection procedures.

WRITTEN MATERIALS. The specification and one set of construction drawings can be made available without charge to Governmental agencies. Non-Governmental requests will be charged for construction prints. Requests for the specification, drawings, or questions on design may be directed to the Forest Service, Equipment Development Center, 444 East Bonita Avenue, San Dimas, California 91773.

The written materials include:

1. Specification 5100-00349 for the Model 51 Crew Tanker.

2. Construction drawings for 300-gallon Model 51 Slip-on Crew Tanker: F83-01 through F83-30.

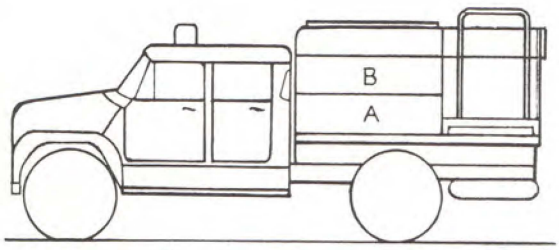
3. Tentative "Instructions for Operation and Care of the 300-gallon Model 51 Slip-on Crew Tanker."

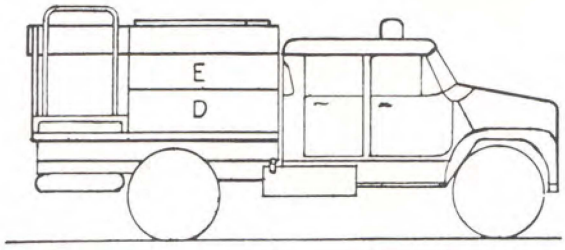
COMPARTMENTS. There is a total of 107 cubic feet of compartment and fire hose bin space in the tanker body. Two dust-proof tool compartments with hinged doors are located on each side of the tanker body. Two additional compartments are accessible from the top of the body for luggage. Long, open-end compartments provide space from the rear for suction hose and a cross-cut saw.

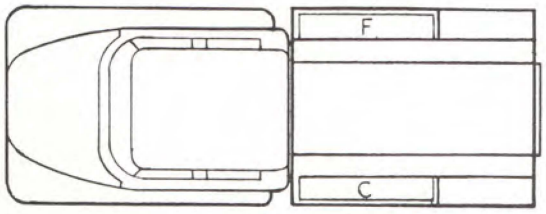
Compartment dimensions are listed below:

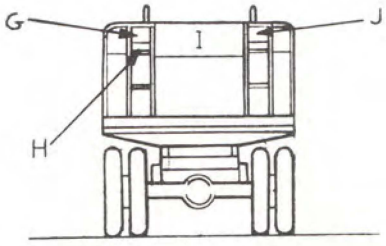
Compartment		Dimensions (Inches)			
Item	No.	Width	Length	Height	Volume (Cu.ft.)
Tools	A (or D)	22½	65½	16-3/4	14.3 (each)
Tools	B (or E)	22½	65½	16-5/8	14.2 (each)
Crew luggage	C (or F)	12	65½	12½	5.7 (each)
Suction hose	G	10½	103	7½	4.7
Cross-cut saw	H	10½	103	3½	2.2
Hose bin	I	41½	103	11	27.2
Suction hose	J	10½	92	7½	4.2

The following illustrations serve as a key to the standard compartments provided.



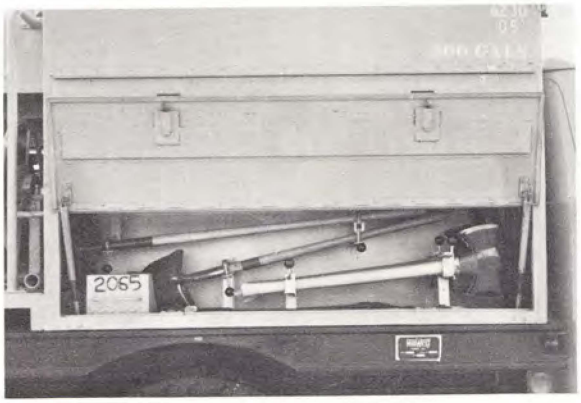






Lower compartment on driver's side (A) showing fittings, canteens and one chock block.

Lower compartment on curb side (B) showing fireline hand tools, one chock block, and other miscellaneous items.



FIRE HOSE AND FITTINGS FOR MODEL 51 ENGINES

Item Description	Federal Stock No.	Quantity Min.	Quantity Max.	Compartment*
ADAPTER, 1" Female I.P. Thread to 1" Male N.H. Thread	-	0	4	A
ADAPTER, 1" Female N.H. Thread to 1" Male I.P Thread	-	0	4	A
ADAPTER, 1-1/2" Female I.P Thread to 1-1/2" Male, N.H. Thread	-	1	2	A
ADAPTER, 2-1/2" Female I.P. Thread to 2-1/2" Male N.H. Thread	-	0	1	A
CLAMP, Shutoff, Pocket-Size; for 1" and 1-1/2" SJ or Linen Hose	4210-00-767-7123	1	5	A
COUPLING, Hose, Double Female:				
1" I.P. Thread	-	1	2	A
1-1/2" N.H. Thread	-	1	2	A
2-1/2" N.H. Thread	-	0	1	A
COUPLING, Hose, Double Male:				
1" I.P. Thread	-	1	2	A
1-1/2" N.H. Thread	-	1	2	A
EJECTOR, Hydraulic, Penberthy 65A Including Foot Valve & Strainer	-	1	1	A
GASKET (Washer) for Hose Coupling Swivel (FS Spec. 102):				
for 3/4" size (13/16" to 1-7/16")	5330-00-599-0776	6	6	A
for 1" size (1-1/16" to 1-7/16")	5330-00-720-2621	12	12	A
for 1-1/2" size (1-9/16" to 2")	5330-00-239-1873	12	12	A
**for 2" size (2-1/16"" to 2-3/8")	5330-00-239-1875	4	4	A
for 2-1/2" size (2-9/16" to 3-1/4")	5330-00-239-1877	6	6	A
HOSE, Fire, High-Pressure, Rubber 3/4" IDx50';Rocker Lug Couplings, with 1" I.P. Thread (FS Spec 185)	4210-00-595-1838	10	10	Reel
HOSE, Single JRL, 1"x100'; Rocker Lug Couplings with 1" I.P. Thread (FS Spec. 5100-00186)	4210-00-777-1591	8	16	B, I

*See page 2.1.3--8 of WHEG
**Not covered by FS Specification 102.

FIRE HOSE AND FITTINGS FOR MODEL 51 ENGINES

Item Description	Federal Stock No.	Quantity Min.	Quantity Max.	Compartment
HOSE, Single JRL, 1-1/2" x 100'; Rocker Lug Couplings with 1-1/2" N.H. Thread (FS Spec.5100-00186)	4210-00-777-1592	6	16	Top
HOSE, Suction, 2-1/2" ID x 8' (FS Spec. 184)	4210-00-595-1839	3	4	G&J
INCREASER, 3/4" Female G.H. Thread to 1" Male I.P. Thread	-	0	1	A
INCREASER, 1" Female I.P Thread to 1-1/2" Male N.H. Thread	-	1	2	A
NOZZLE, Fire Hose, Combination 1" I.P. Thread Base	-	6	12	A
NOZZLE APPLICATOR 48" long with 3/4" G.H. Threads both ends	-	0	1	A or B
NOZZLE, Fire Hose, 1-1/2" N.S. Thread base	-	1	2	A
REDUCER, 1-1/2" Female N.H. Thread to 1" Male I.P. Thread	-	0	1	A
REDUCER, 1-1/2" Female I.P. Thread to 1" Male I.P. Thread	4210-00-294-2648	0	1	A
REDUCER, 2-1/2" Female N.H. Thread to 1-1/2" Male N.H. Thread	-	1	1	A
REDUCER (-Adapter), 1" Female I.P. Thread to 3/4" Male G.H. Thread	-	0	1	A
REDUCER (-Adapter), 1-1/2" Female N.H. Thread to 1" Male I.P. Thread (FS Spec. 104)	4210-00-975-2969	6	12	A
REDUCER (-Adapter), 2" Female I.P. Thread to 1-1/2" Male N.H. Thread	-	0	1	A
STRAINER, Suction, Fire Hose, Globe Shaped 2-1/2" Female N.H. Thread Intake (FS Spec.5100-00105)	4210-00-203-3228	1	1	(Opr. panel)

FIRE HOSE AND FITTINGS FOR MODEL 51 ENGINES

Item Description	Federal Stock No.	Quantity Min.	Quantity Max.	Compartment
VALVE, Check & Bleeder, Inlet and Outlet 1-1/2" N.H. Thread; Bleeder Outlet 1" I.P. Thread (FS Spec. 382)		1	1	A
WRENCH, Hydrant, Adjustable	-	1	1	A
WRENCH, Spanner, 1"-1/2" Combination (FS Spec. 5100-101)	5120-00-596-1426	2	5	A
WRENCH, Spanner, 1", 1-1/2". and 2-1/2" Combination (FS Spec. 5100-101)	5120-00-596-1427	1	2	A
WYE, Two-Way, Gated, 1-1/2"N.H. Thread (FS Spec. 5100-380a) OR TEE, Hoseline (Valve) 1-1/2"x 1-1/2" N.H. Thread x 1" I.P. Thread	4210-00-984-3475	4	15	A, I
WYE, Two-Way Gated, 1" I.P. Threads	4210-00-126-5108	0	1	A

MISCELLANEOUS TOOLS & EQUIPMENT FOR MODEL 51 ENGINES

Item Description	Federal Stock No.	Quantity Min.	Quantity Max.	Compartment
BAR, Wrecking, 3/4" x 36"	5120-00-242-0762	1	1	D
BOX, Tool, Steel (19"x7"x7")	5140-331-5496	1	1	D
(Box, Tool - Contents):				
Chisel, Cold (5" x 3/8")	5110-242-3457	1	1	
File, Hand Knife (smooth cut Style C 6")	5110-203-4552	1	1	
File, Hand, Mill (Regular, smooth cut Style 12")	5110-203-4645	1	3	
File, Hand, Mill (Regular, Bastard Cut, 12")	5110-242-5386	1		
File, Handle (Wood, Small	5110-263-0342	1	1	
File, Handle (Wood, Large)	5110-263-0341	2	4	
Hammer, Ball-peen, 1/2 lb.	5120-242-3913	1	1	
Pliers, Side Cutter (Lineman's) 8"	5120-00-756-1156	1	1	
Pliers, Slip Joint (Hose Clamp; 7-5/8")	5120-537-3375	1	1	
Screwdriver, Combination (1/4" Flat tip x No.2 cross tip)	5120-301-1076	1	1	
Screwdriver, Flat Tip (8" x 3/16")	5120-988-6489	1	1	
Wrench, Open End (Adjustable 3/4" x 6")	5120-264-3795	1	1	
Wrench, Open End (Adjustable 1-5/15" x 12")	5120-264-3796	1	1	
Wrench, Open End (Fixed; Double Head 3/4" x 7/8")	5120-264-3796	1	1	
CUTTER, bolt		1	1	D
EXTINGUISHER, Fire (Dry Chemical) 5 lb. Minimum		1	2	
GEAR, Personal Items				C, E, or F
GOGGLES, Industrial	4240-01-055-2310	5	5	B
KIT, First Aid (10-unit #2) w/kit Snakebite	6545-00-656-1093	1	1	B
KNAPSACK *	8465-00-205-3493	2	6	B or E
LANTERN, Electric	6230-00-500-0523	0	1	D or E

*Does not include knapsacks for personal gear

MISCELLANEOUS TOOLS & EQUIPMENT FOR MODEL 51 ENGINES

Item Description	Federal Stock No.	Quantity Min.	Quantity Max.	Compartment
OIL, Motor, (quart)		1	1	C
PACKBOARD, Plywood		0	8	B
PAIL, Nylon, 3 gal. collapsable	8465-00-128-6928	0	1	B
RATION, Combat, Individual	8970-00-577 4513	6	12	B or E
ROPE, Nylon, 1/2" (100')		1	1	E
WRENCH, Pipe, Adjustable (2-1/2" x 24")	5120-00-277-1480	1	1	A
WRENCH, Pipe, Adjustable (2" x 18")	5120-00-277-1479	1	1	A

FIRELINE HAND TOOLS FOR MODEL 51 ENGINES

Item Description	Federal Stock No.	Quantity Min.	Quantity Max.	Compartment
AXE, DB, Cruiser; 2-1/2 lb., 27" handle (FS Spec. 9: Type C)	5110-00-293-3300	0	1	D
CANTEEN, Water, 4 qt. (FS Spec. 5100-0083)	8465-00-082-3054	5	6	A
FUSEE, Backfiring, 10-Min. (FS Spec. 5100-360a)	1370-00-294-1279	0	24	B
TORCH, Drip, Backfiring		0	1	
HAMMER (Sledge), Stoneworker's 8 lb., 32" handle	5120-00-251-4489	1	1	D
HEADLAMP, Electric	6230-00-643-3562	6	6	B
(HEADLAMP) BATTERIES, Dry, Size D	6135-00-835-7211	24	24	B
HOOK, Brush, 10-1/4" blade, 36" handle (FS Spec. 5100-00180a)	3750-00-240-3085	2	4	D
McLEOD TOOL (FS Spec. 5100-353)	4210-00-203-3512	2	3	D
OUTFIT, Back-pack Pump, Neoprene Coated (FS Spec. 5100-257)	4320-00-289-8912	1	3	B
PULASKI TOOL (FS Spec. 5100-355)	5120-00-293-3467	2	4	D
SAW, Two-man Crosscut, felling w/handles, 6"	5110-062-6625	0	1	H
OR				
SAW, Power	-	0	1	C
FUEL, Power Saw, 3 gal.	-	0	1	C
(SAW) OIL, 1 qt. (for Power Saw)	-	0	2	C
SHELTER, Forest Fire with belt carry case (FS Spec. 5100-320)	4240-01-062-8226	6	6	B
SHOVEL, Hand, Forest Fire Fighting Size 1 (FS Spec. 5100-00326)	5120-00-965-0609	3	5	D

FIRELINE HAND TOOLS FOR MODEL 51 ENGINES

Item Description	Federal Stock No.	Quantity Min.	Quantity Max.	Compartment
WEDGE, Steel, 8-lb., 9-1/2" long; width of bit edge 4-1/4"	5120-00-293-3405	0	1	D
WEDGE, Timber, Wood or Plastic, 3" wide, 11" long	5510-00-640-9237	2	4	D
BLOCK, Chock	-	2	2	A & D
CHAINS, Snow & Mud Tire (set)	-	0	1	C or F
CHAIN, Tow, 3/8" x 20'	4010-00-171-4427	1	1	C or F
GAUGE, Tire Pressure, to 130 lbs. 12-1/2" long	4910-204-3170	1	1	Cab
JACK, Hydraulic, Hand, w/handle, 8-ton, 11-1/2 to 22-1/8" rise	5120-061-0728	1	1	D
REFLECTOR, Stalled Warning	-			D
WRENCH, Lug, Wheel	-	1	1	D
OIL, Transmission, Quart	-	1	1	C

PLASTIC TANK SLIP-ON CONSTRUCTION

Model 30 . . . . . 75-, 125-, & 200-Gallon Tank

2.2 - DESIGN CONSIDERATIONS. The design considerations for the Model 20 Tanker sizes (see page 2.1--1) also cover the Model 30 Plastic Tanker.

Since all Model 30 tankers are top-mounted, the operator must stand in the truck bed when starting the engine and for some other operating procedures.

COST AND SERVICE LIFE. Generally speaking, plastic (fiberglass) construction is more costly than mild steel. However, in a limited study made in 1968, the initial cost of one tank each was around $100 less in plastic than in mild or stainless steel. The comparison was made in the 125-gallon size and from one fabricator only. The cost of the plywood mounting top and tank filler cap was included in the plastic cost. The metal tank system cost included the aluminum cap, water gauge, plugs, and in-tank valve and linkage.

The service life of metal tanks is running from 12 to 14 years. Plastic tank life expectancy will probably be lower, with the cost about equal, amortized over a period of use-years. Simple repairs can be made by the operator with plastic kits.

WEIGHTS. Following are weights determined for a 125-gallon tank assembly with the necessary and related hardware and parts:

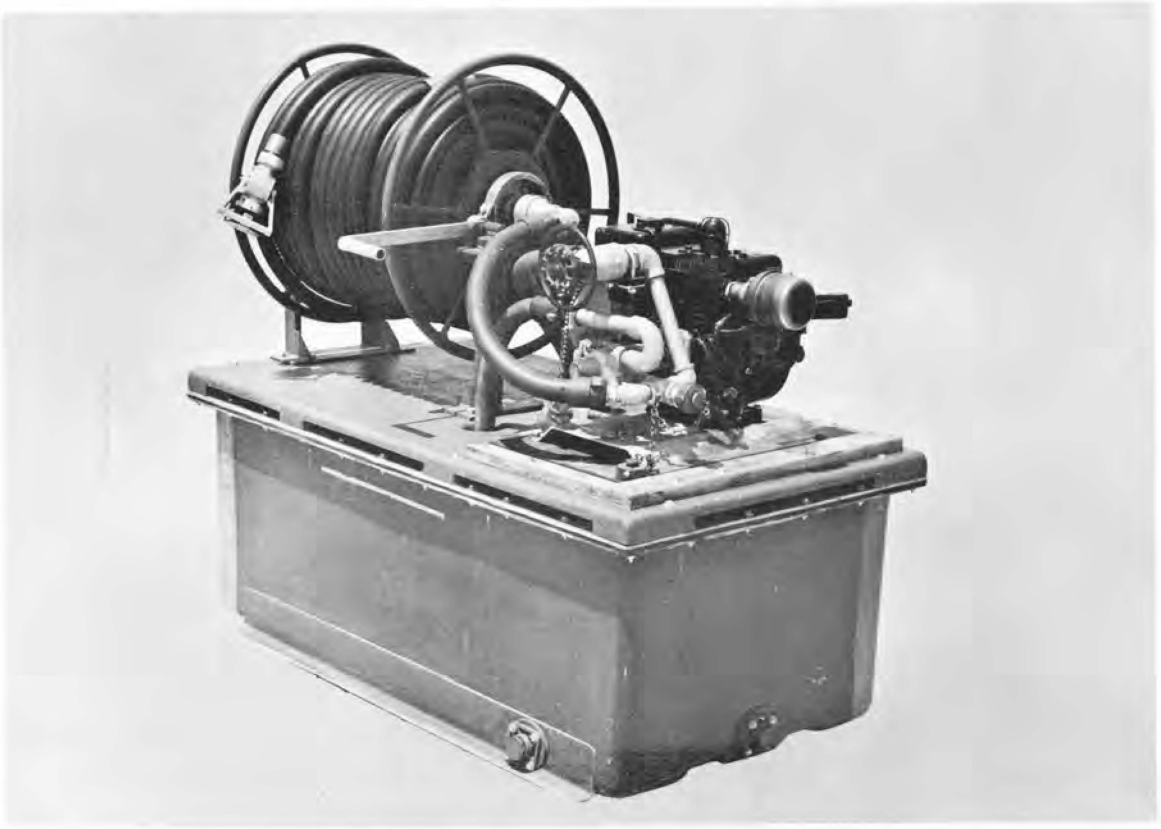
	Mild Steel	Stainless Steel	Fiberglass
Weights (pounds)	226	214	181

The above weight saving is not enough to influence the size of truck (GVW) required for identical Model 20 and 30 capacities (see 2.0--3). However, the weight differences would permit the use of more handtools, equipment for the job, or personal gear.

MODIFICATIONS. Changes in shape, size, or even minor adaptations are extremely costly in plastic construction since the tank is built on a rather expensive die. We hope this fact will assist in standardization.

MODEL 30 SLIP-ON TANKER

Tank Sizes: . . . . . 75-, 125-, and 200-gallon
Crew Size: . . . . . 1- or 2-man
Pumper Performance: . . . . . Optional
Style: . . . . . Top-mounted; plastic tank construction
Standard: . . . . . Service-wide use; USDA - Forest Service

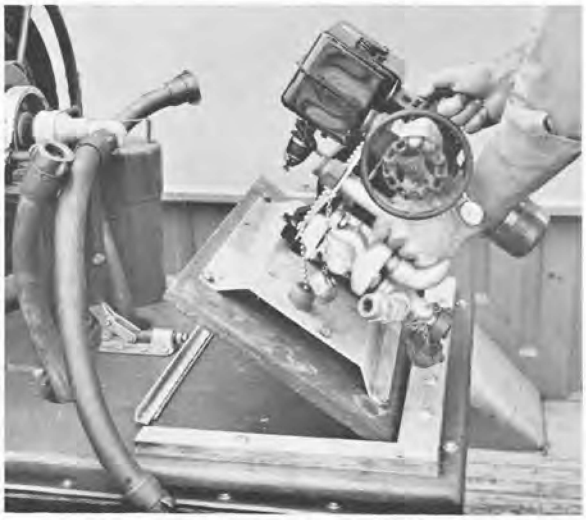


2.2.1 - GENERAL. Model 30 plastic slip-on tankers are available in three standard tank sizes – 75-, 125-, and 200-gallon. These tankers consist of a lightweight plastic tank, a plywood mounting platform, a reel, and a portable pumper. The slip-on can be easily and quickly installed on a light pickup. The truck aisle must be at least 48 inches wide for the 125- and 200-gallon tankers.

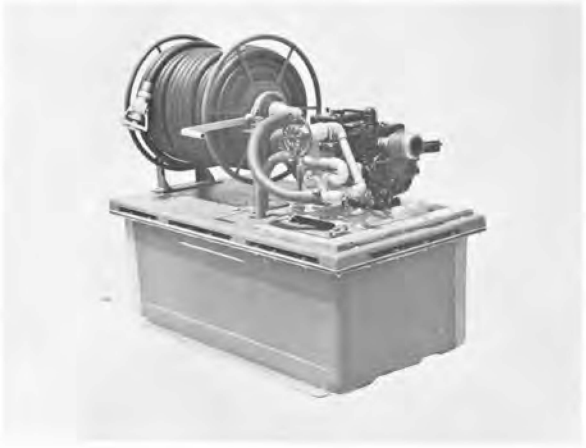
Two diagonally opposite corners of the tank are translucent from top to bottom to show the water level.

A plywood mounting platform is installed on the top of the tanker to distribute the weight of the reel and pumper and to permit removal of the platform without disturbing the tank top seal.

A number of Forest Service qualified four-cycle, engine-driven centrifugal and positive displacement pumpers can be mounted on a similar baseboard and installed on the mounting platform. To install a pumper on the mounting platform, place the baseboard into a hold-down bracket and lock it into place. Two hoses from the tank and one from the hose reel are then connected to the pumper with the use of a spanner wrench, the only tool required. When the pumper is equipped with an electric starter, two electric cables from the truck are also connected to the pumper.



With the pumper installed on the tank top, the unit can pump from "tank to fire," from "draft to fire," or from "draft to tank." If necessary, the pumper can be removed from the tanker in a few minutes and carried to a water source or used as a portable pumper. A pumper in need of repairs can be removed from the tanker by any fireman and replaced with a serviceable pumper. Most pumpers require two men to lift and transport.



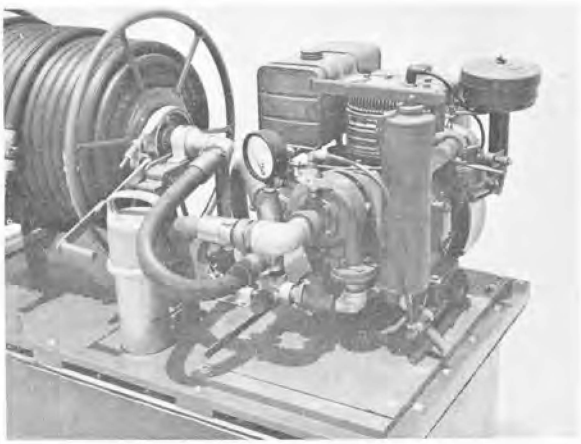
CONTROLS. Plastic slip-on tankers are simple to operate. Normally the soft plumbing lines are connected for a "tank to fire" operation, using a hose reel line. A second overboard discharge line connection is provided in the basic plumbing.

To "draft," the coupling is disconnected at the intake of the pumper and the suction hose is attached. The tank can be refilled, or the water can be delivered to the fire.

If an inaccessible water source is located within reach of the reel hose line, the tank can be easily filled. The portable pumper is moved to the water source and connected to the nozzle end of the hose line with a 1" double female coupling. A soft hose plumbing line long enough to reach the filler spout is used, and refilling is begun.

The pumper can also be carried to a water source, and used directly on the fireline, independent of the truck. Since the pumper is mounted on the baseboard the entire assembly with the Model 30 plumbing can be used on the line assignment. The basic pumper weights are increased somewhat. (See "Pumper Options Available.")

No valves are used in plumbing except the relief valve for positive displacement pumps and the check valve for centrifugal units. Rigid plumbing is used to make relief valve controls and spanner connections more accessible. Freeze protection is provided by elevating the relief valve and sloping the connection hose lines and pipe sections. By including the rigid plumbing on the pumper, the tank length is held to a standard length of 50-1/2 inches.



As in all top-mounted models, the operator must be in the bed of the vehicle to start and adjust the engine and to make any hose line connection. However, the nozzle, the reel release, and the relief valve can be reached from ground level on the pickup driver's side.

Electric starters are available and recommended on **all units except** the small Briggs-Eco. In an emergency, a rope starter can be used. Electrical connections are provided to the vehicle battery.

SLIP-ON DIMENSIONS (inches)

Tank Size	Slip-on with reel overall			Tank only		
	Width	Length	Height*	Width	Length	Height
75	27-1/2	50-1/2	44	27-1/2	50-1/2	17-1/2
125	47	50-1/2	43	47	50-1/2	16-1/2
200	47	50-1/2	51	47	50-1/2	24-1/2

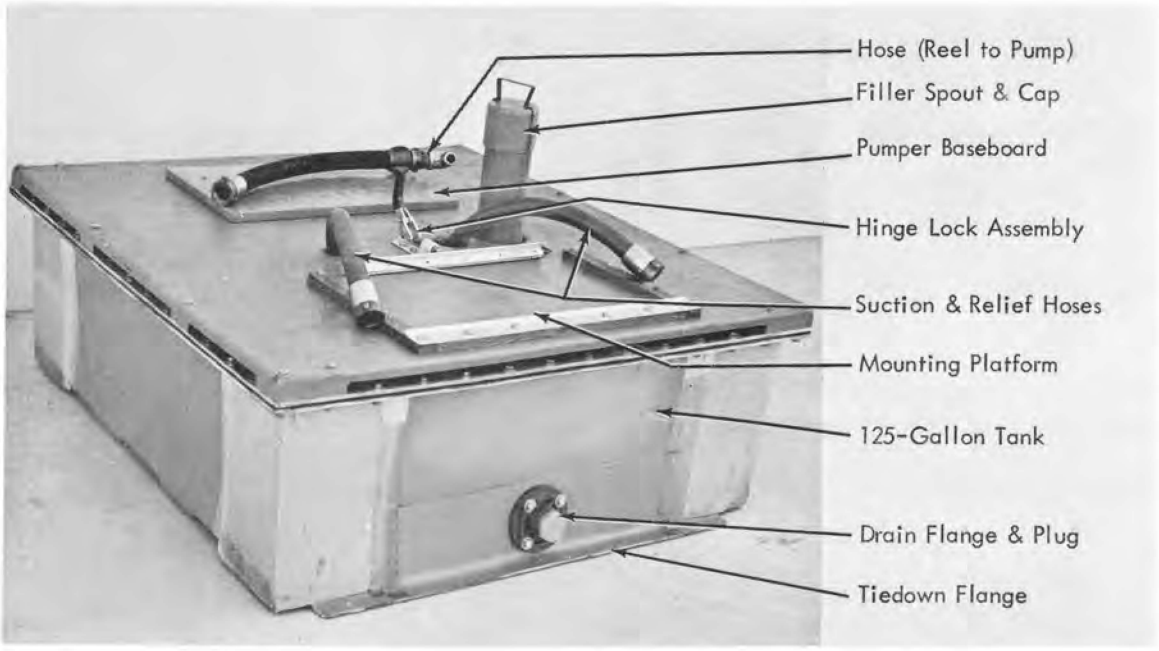
*Measurement from the high point of the reel to the tanker base.

SLIP-ON WEIGHTS (POUNDS) WITH REEL BUT WITHOUT PUMPER (See page 2.2.1--6 for exact pumper weights to be added, based on pumper selected.)

Tank Capacity (Gallons)	Slip-on Weight (Pounds) Less Pumper		Suggested Truck (GVW)	
	Dry	Wet	4x2	4x4
75	270	963	5,800	6,400
125	321	1,377	6,300	6,900
200	339	2,074	7,200	8,000

The illustration with a 75-Gallon Slip-on (Briggs-Eco pumper) shows how accessible the tank filler spout and cap are to a crewman standing on the ground. The spouts on all sizes were moved from the driver side to the curb side by official change order in August 1969. Hydrant filling, as demonstrated, is most common in FS use.

TANK DESCRIPTION



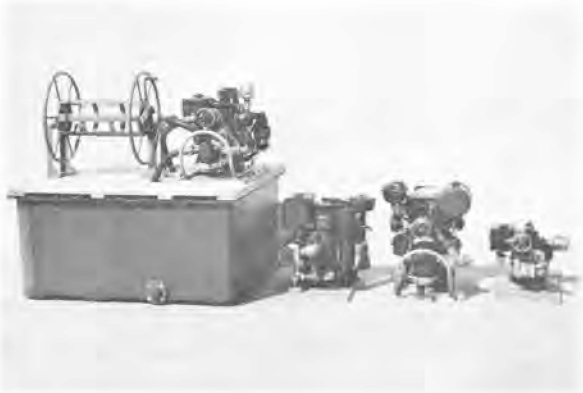
The tanks are constructed of fiberglass-reinforced plastic. The finished material is not less than 3/16" thick at any point. Tiedown flanges on the 125- and 200-gallon tanks are placed front and back, but on the 75-gallon they are installed along the sides. Two PVC drain plugs are installed, one on one end and one on one side.

A hole or crack in the plastic tank may be repaired in the field by applying fiberglass repair patches or strips to the damaged area.

MOUNTING PLATFORM. A platform of exterior plywood covers the entire top and bears all of the weight. The platform is laminated, on the top side only, with one layer of resin-sealed fiberglass cloth or mat. Clear resin is applied to the under surface. The pumper baseboard is similarly constructed and is treated on both sides with mat and resin.

COLOR OPTIONS. Either green or red can be selected for the basic tank, mounting platform, baseboard, and reel. Ordinarily the pumper color is not changed.

REEL. The standard Forest Service reel is used with 250' of 3/4"-ID high-pressure rubber hose with 1" couplings. On the basis of hydraulic tests, the use of premium garden hose on fire tankers is not recommended.



PUMPER OPTIONS AVAILABLE.

Nine centrifugal and positive displacement qualified pumpers have been plumbed into the Model 30 systems. (See section 3, "Summary of Advantages and Disadvantages of Centrifugal and Positive Displacement Pumps.") A limited amount of carefully selected hardware is added to the selected pumpers so they will easily tie into the three soft hose lines on the slip-on. A second overboard discharge is available.

Although the pumper is firmly attached to the baseboard, pumpers can be exchanged with a spanner wrench in less than 3 minutes.

Following are the pumpers selected, all with four-cycle engines:

Make and Model	Coding*	Weight*** Wet	Weight*** Dry	Performance 50	100	150	200	250	FS Dwg. No.
Berkeley B1-1/2XQBS-10	C-175-15/35	215	226	52	44	35	18		F82-20
Cedco A10F	P-130-40/08**	138	146	--	---	--	--		F82-14
Cedco or Hale HPZZ	C-175-20/15	180	191	60	30	20	15		F82-11
Edwards L-23	P-175-20/25	189	202	49	47	37	28		F82-15
Edwards EBE	P-045-15/08	53	59	11	11	10	--		F82-10
Pacific Pumper BE	P-045-15/08	53	59	11	11	10	--		F82-10
Pacific Pumper WA-7	P-130-25/15	118	125	26	25	24	21	17	F82-09
Pacific Pumper WX-10	P-175-20/20	187	204	45	43	32	24		F82-08
Western Fire 14x120A	P-045-15/10	53	59	11	11	10	--		F82-10

*For coding explanation see FS Specification 5100-273a and "Performance Codings," section 3.0. Prefix "C" stands for centrifugal; "P" for positive displacement.

**Unit rated at 10 gpm @ 425 psi, but the relief valve is set at 400 psi in the final assembly and the engine is governed at a constant speed.

***As installed, with additional hardware and baseboard.

AVAILABILITY. FS Specification 5100-00342 (June 1968) and FS Drawings F82-02 through F82-04, and F82-07 describe the construction of the 75-, 125-, and 200-gallon plastic . . . tank. This specification requires that a representative from the San Dimas Equipment Development Center inspect the facilities and methods of any bidder. At least one tank will be constructed to specifications, and a prequalification notice will be issued by the Forest Service. To date only one qualification notice has been issued

Sims Fiberglass Company, P.O. Box 36, Jefferson, Oregon 97352
(telephone (503) 327-2248)

A list of qualified pumpers which have been plumbed for use on Model 30 slip-on tankers is included on page 2.2.1--6 of this description. For more detail see sections 3.0, 3.2, and 3.3.

ASSEMBLY. FS Specification 5100-343a (June 1968) and FS Drawings F82-01 through F82-04, F82-06 through F82-12, and F82-15 describe the final assembly of the tank, mounting platform, reel, pumper, and related items. Prequalification is not required under this specification, but inspections and tests will be performed on the work. To date the following fire equipment suppliers have done Forest Service plastic tank assembly work:

C. E. Duggan Co., 293 E. Santa Fe Dr., Pomona, Calif. 91767
Pacific Pumpers, 1223 Western Ave., Seattle, Washington 98101
Sims Fiberglass Co., P.O. Box 36, Jefferson, Oregon 97352
Western Fire Equipment Co., 69 Main St., San Francisco, Calif. 94105

No particular Region has been designated to handle Model 30 purchases; and personnel are encouraged to handle orders or bids direct, in line with local instructions, as the need arises. The Equipment Development Center at San Dimas does not handle any fire protection agency purchases.

WRITTEN MATERIALS. Specifications and one set of construction drawings are available to all Governmental agencies. A charge will be made for construction drawing prints for non-Governmental requests. The Equipment Development Center, 444 E. Bonita Avenue, San Dimas, California 91773, is serving as custodian for the following written materials:

1. Interim Specification 5100-00342, Tank, Plastic, Fiberglass-reinforced, 75-, 125-, and 200-gallon.

2. Interim Specification 5100-00343a, Tanker, Slip-on, Plastic, capacity 75-, 125-, and 200-gallon.

3. Construction Drawings F82-01 through F82-07, plus one additional drawing (from the series F82-08 through F82-20) for the pumper selected (see page 2.2.1--6).

4. Instructions for Operation and Care of 75-, 125-, and 200-Gallon Model 30 Plastic Slip-on Tanker.

5. Forest Service Data Sheet for appropriate engine-driven pumper (specify make and model).

FIRE HOSE, FITTINGS, AND MISCELLANEOUS TOOLS AND EQUIPMENT FOR MODEL 30 TANKERS

Description	Federal Stock No.	Quantity
- FIRE HOSE AND FITTINGS -		
APPLICATOR, 48" Aluminum Extension, 45° Bend, 3/4" Male G.H. Thread on Nozzle End, 3/4" Female G.H. Thread on Inlet End	None	1
COUPLING, Hose, Double Female, 1" I.P. Thread	None	1
COUPLING, Hose, Double Male, 1" I.P. Thread	None	1
GASKET (Washer) for Hose Coupling Swivel (FS Spec. 102)		
For 3/4" size	5330-599-0776	10
For 1" size (1-1/16" to 1-7/16")	5330-720-2621	10
For 1-1/2" size (1-9/16" to 2")	5330-239-1873	5
HOSE, Fire, High-Pressure, 3/4" ID x 50'; Rocker Lug Couplings with 1" I.P. Thread (FS Spec. 185)	4720-595-1838	4
HOSE, Suction, 1" ID x 8'; Rocker Lug Couplings with 1" I.P. Thread (FS Spec. 184). For Pumpers with 1" Inlet (Cedco A10F, Edwards EBE, Pacific Pumper WA-7 and BE, and Western Fire 14X120A)	None	3
HOSE, Suction, 1-1/2" ID x 8'; Rocker Lug Couplings with 1-1/2 N.S. Thread (FS Spec. 184). For Pumpers with 1-1/2" Inlet (Edwards L-23, Pacific Pumper WX-10, Cedco or Hale HPZZ, Berkeley B1-1/2XQBS-10)	4210-889-1774	3
INCREASER, 3/4" Female G.H. Thread to 1" Male I.P. Thread	None	1
INCREASER, 1" Female I.P. Thread to 1-1/2" Male N.S. Thread	None	1
NOZZLE, Fire Hose, Fog and Solid-Stream Combination; 1" I.P. Thread Base, (R-5 FS Spec.). Complete with four tips: 3/16" Solid-Stream 3/8" Solid-Stream #3 Fog, 2-4 GPM #6 Fog, 5-7 GPM	4210-640-1892	1

FIRE HOSE, FITTINGS, AND MISCELLANEOUS TOOLS AND EQUIPMENT FOR MODEL 30 TANKERS (Cont'd)

Description	Federal Stock No.	Quantity
- FIRE HOSE AND FITTINGS (Cont'd) -		
REDUCER (Adapter), 1" Female I.P. Thread to 3/4" Male G.H. Thread	None	1
REDUCER (Adapter), 1-1/2" Female N.S. Thread to 1" Male I.P. Thread (FS Spec. 104)	4210-975-2969	1
STRAINER, Suction, Fire Hose, Globe-Shaped, 1" Female I.P. Thread. For Pumpers with 1" Inlet	None	1
STRAINER, Suction, Fire Hose, Globe-Shaped, 1-1/2" Female N.S. Thread. For Pumpers with 1-1/2" Inlet	4210-984-3460	1
TIP (NOZZLE), 1/4" Solid-Stream, 3/4" G.H. Thread (FS Spec. 5100-00244)	4210-204-3358	2
- MISCELLANEOUS TOOLS AND EQUIPMENT -		
BOX, Accessory	None	1
CONTAINER, Pumper Maintenance Instruction	None	1
GAGE, Feeler, Spark Plug	5210-189-9538	1
INSTRUCTIONS, Pumper Maintenance, include the following pamphlets:		
Engine Instruction Manual (mfrs.)	None	1
Pumper Instruction Manual (mfrs.)	None	1
Pumper Parts Manual (mfrs.)	None	1
Instructions for Operation and Care of 75-, 125-, and 200-Gallon Model 30 Plastic Slip-On Tanker (SDEDC)	None	1
PAIL, Canvas	8465-582-1277	1
PLUG, Spark, A.C. No. C86 Commercial or Autolite No. BT-8 or Equal. (For Wisconsin BKND and AENLD; and Briggs & Stratton 80332 Engines)	2920-540-8352	1
PLUG, Spark, A.C. No. GC46 or Autolite A7, or Equal. (For Briggs & Stratton 23A-FB, 243434, and 142451 Engines)	2920-540-8342	1
ROPE, Starter	2990-294-0934	1

FIRE HOSE, FITTINGS, AND MISCELLANEOUS TOOLS AND EQUIPMENT FOR MODEL 30 TANKERS (Cont'd)

Description	Federal Stock No.	Quantity
- MISCELLANEOUS TOOLS AND EQUIPMENT (Cont'd) -		
WRENCH, Open End, 13/16" x 7/8"	5210-184-8559	1
WRENCH, Spanner, 1" and 1-1/2" Combination (FS Spec. 5100-101)	5210-596-1426	1

INTEGRAL TANKER CONSTRUCTION

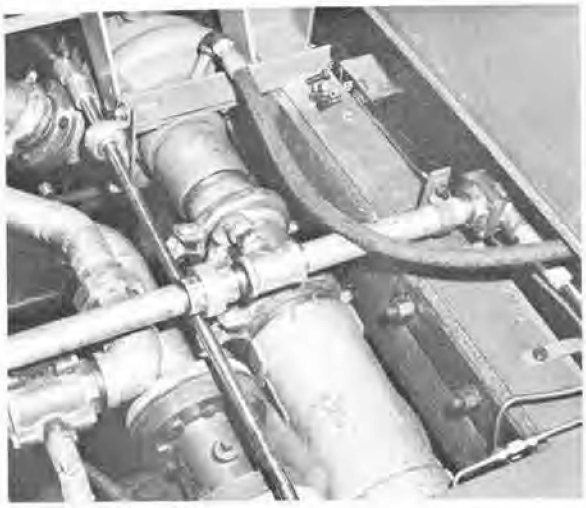
Model 40 . . . . . 75-, 125-, & 200-Gallon Tank
Model 60 . . . . . 500-Gallon Tank
Model 56 . . . . . 300-Gallon Tank

2.3 - DESIGN CONSIDERATION. The design considerations for the Model 20 tanker sizes (see section 2.1) were generally used in the early construction of the Model 40 PTO tankers. The "preferred tanker operator position," just behind the driver's cab door, was used. This makes for a more efficient initial attac by a small crew. In the 75-, 125-, and 200-gallon sizes, tankers are lighter and less expensive than the metal slip-ons. However, the reverse is true of the 300-gallon sizes.

The Model 60 tanker is considered separately. It is described in detail in section 2.3.2.

PTO INSTALLATIONS.

The selection of a PTO tanker assumes that careful consideration has been given to the vehicle to be used. While the installation of the pump drive assembly is rather simple in the Model 40, this is not true of the Models 56 and 60. The photograph shows the centrifugal pump (upper right) and the related plumbing as permanently installed in the Model 60.



A detailed explanation follows for each Model PTO system used in FS practice. Actually, most of these models are in operation in the California Region.

MODEL 40 POWER TAKE-OFF TANKER

Tank Sizes: . . . . . 75-, 125-, and 200-gallon
Crew Size: . . . . . 1- or 2-man
Tanker Performance: . . . . . 70 gpm @ 200 psi
Style: . . . . . Integral unit; all-metal construction
Standard: . . . . . California Region; USDA - Forest Service

2.3.1 - GENERAL. The Model 40 Power Take-Off Tanker is provided in three tank sizes - 75-, 125-, and 200-gallon. The vehicle engine, or pump power source, is already running upon arrival at the fire. This insures fast action at the fire. The operator can engage the pump before leaving the cab and can reach all controls easily.

The driver has unrestricted visibility with the hose basket installation.

The low silhouette tanker shown above as a 200-gallon tanker with live hose basket has a well-balanced load and good road-handling characteristics.

All water accessories and handtools are readily accessible.

This integral tanker was designed primarily for initial attack on small fires by a one- or two-man crew.

If the fire load and length of fire season warrant an integral tanker design, this power take-off unit is a logical selection since it is somewhat lighter and less expensive than comparable slip-on types.

Tanker Weights and Truck Options

Tank Size (Gallons)	Added Weight*		Suggested Truck GVW's	
	Dry	Wet	4x2	4x4
75	2,260	2,870	6,500	7,100
125	2,290	3,340	7,300	7,600
200	2,500	4,170	8,500	9,000

*Provides for the truck body, water load, typical accessories and equipment, and a two-man crew. The curb weight of the basic vehicle is not represented in these figures.

Dimensions of Unit in Vehicle Bed

Tank Size (Gallons)	Overall Assembly With Basket**		
	Width	Length	Height
75	47-1/2"	46"	28"
125	47-1/2	50	32
200	47-1/2	65	32

**To top of hose basket, but excluding filler spout and cap.

Tank Description

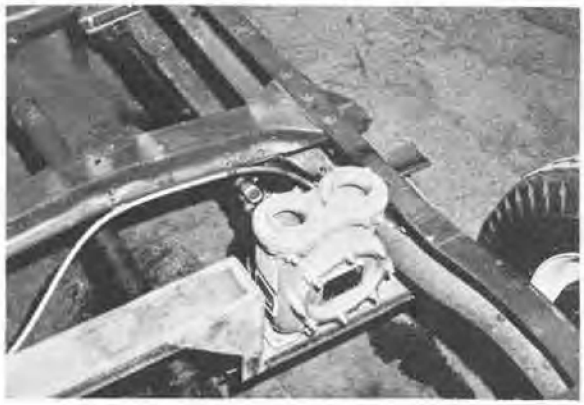
- 14-gauge welded sheet-metal construction
- Full tank top access
- 4" ID lightweight filler spout cap
- Hot dip galvanize tank coating
- 1 1/2" N.P. Thread plumbing connection.

Reel or Hose Basket Option: If the standard Forest Service reel is selected, 250' of 3/4" ID high-pressure rubber hose may be used. If the hose basket is preferred, it can be equipped with 200' of 1" single cotton-synthetic jacket, lined hose. A few forestry agencies prefer double-jacketed hose. (See section 2.6.1 and 2.6.2.)

The hose basket is provided in two sizes. The 75-gallon size is 27-3/8" x 43-1/2" x 13", and the 125/200-gallon size is 44-5/8" x 44-5/8" x 8", inside dimensions.

A tubular rim provides a smooth, rounded edge for hose protection. All hose baskets are equipped with duckboard in the bottom. A fire-resistant cover is also provided in the drawings. A four-way hose-roller is essential with baskets.

Color of tank, reel or basket, and protective cage . . . . . green



POWER TAKE-OFF. The vehicle engine is used to drive the pump in this power take-off assembly. A DANA Spicer AA type is generally used to fit the particular truck transmission supplied.

PUMP. A pump capable of 70 gpm @ 200 psi at a truck engine speed of 2,600 rpm is specified for any tank size used. A Gorman-Rupp Model 02F1-GR self-priming, single-stage, centrifugal pump has been used satisfactorily in this assignment. Forest Service hydraulic tests rate this bare pump at 132 gpm @ 200 psi driven at an engine rpm of 2,500.

This pumper performance is reduced somewhat by plumbing. The following is representative performance at the overboard hose connection:

PSI	50	100	150	200
GPM	80	79	75	70

The flow rates are restricted to these values through the plumbing system plus 24 feet of 1-1/2" suction hose at a 2' lift and a vehicle engine speed of 2,500 rpm.

At lower elevations, the pump is capable of developing a dry suction lift of 15 feet provided the pump has priming water in it.

PLUMBING. A 2 1/2" hydrant cap offers access with a spanner wrench. A 16-gauge wire mesh stainless steel strainer screens water entering the pump.

The cleanout trap and the flexible plumbing lines running to and from the tank to the controls are protected by a light metal frame guard.

Reel or Hose Basket Option: If the standard Forest Service reel is selected, 250' of 3/4" ID high-pressure rubber hose may be used. If the hose basket is preferred, it can be equipped with 200' of 1" single cotton-synthetic jacket, lined hose. A few forestry agencies prefer double-jacketed hose. (See section 2.6.1 and 2.6.2.)

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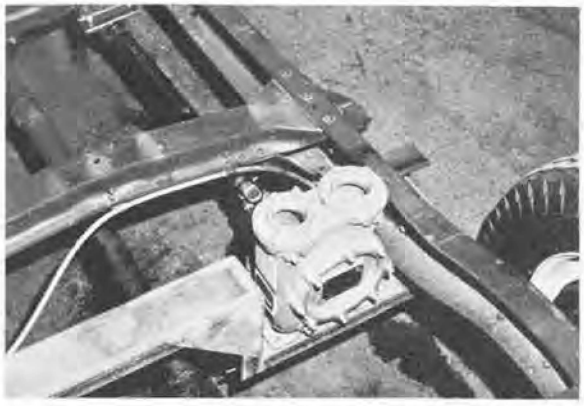

POWER TAKE-OFF. The vehicle engine is used to drive the pump in this power take-off assembly. A DANA Spicer AA type is generally used to fit the particular truck transmission supplied.

PUMP. A pump capable of 70 gpm @ 200 psi at a truck engine speed of 2,600 rpm is specified for any tank size used. A Gorman-Rupp Model 02F1-GR self-priming, single-stage, centrifugal pump has been used satisfactorily in this assignment. Forest Service hydraulic tests rate this bare pump at 132 gpm @ 200 psi driven at an engine rpm of 2,500.

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PSI	50	100	150	200
GPM	80	79	75	70

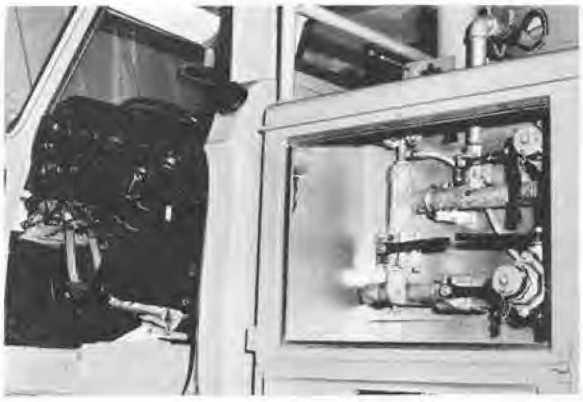
The flow rates are restricted to these values through the plumbing system plus 24 feet of 1-1/2" suction hose at a 2' lift and a vehicle engine speed of 2,500 rpm.

At lower elevations, the pump is capable of developing a dry suction lift of 15 feet provided the pump has priming water in it.

PLUMBING. A 2 1/2" hydrant cap offers access with a spanner wrench. A 16-gauge wire mesh stainless steel strainer screens water entering the pump.

The cleanout trap and the flexible plumbing lines running to and from the tank to the controls are protected by a light metal frame guard.

CONTROLS. The pump engaging lever is in the cab beside the gearshift; the engine throttle is on the left side of the instrument panel. Switches for the "kill" feature and for the red light and siren are also added to the vehicle panel. The controls in the cab and those in the outside compartment are all located on the driver's side and are readily accessible.



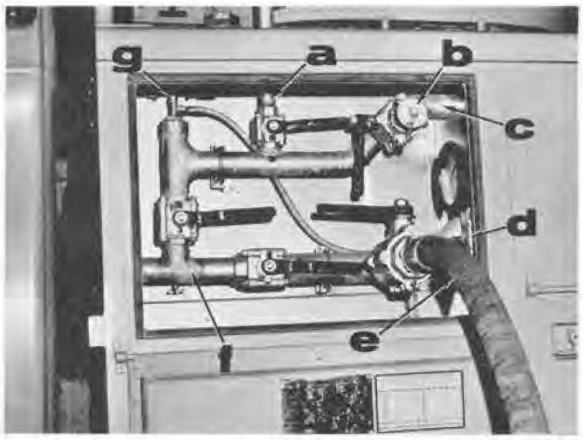
"Tank to fire," "draft to fire," and "draft to tank" procedures are described on a brass instruction plate mounted on the exterior panel. A standard numbering system for all control valves has been adopted for the California Region.

The basic plumbing is in full view and within easy reach. The layout in the control compartment is essentially a manifold with the necessary ball valves, which may be quickly removed for repair.

A full tank of water can be held over after the pump and plumbing have been drained. Winter drainage points have been provided and are readily accessible.

Control and plumbing details are visible in the photograph:

a. 1" line to hose basket or reel
b. 1-1/2" overboard line
c. Line from pump
d. Line to pump
e. Draft hose
f. Line to tank
g. Tank valve shutoff



AVAILABILITY. The Regional Administrative Office of the California Region (5) has been issuing annual construction bids about September 1. Delivery is usually made the following spring or summer. Other Regions and other Federal agencies have been procuring tankers through R-5.

WRITTEN MATERIALS. Specification(s) and one set of construction drawings are available to all Government agencies. A charge will be made for construction drawing prints for non-Governmental requests. Requests should be directed to the Regional Forester, California Region, for current specifications or construction drawings. Design interpretation and related inquiries may be directed to the Equipment Development Center, 444 E. Bonita Avenue, San Dimas, California 91773.

The California Region considers those units built prior to CY 1965 in a "limited" standard category and the specification and related drawings are no longer maintained.

Written materials include:

1. Specification 5100-R5-04 for 75-, 125-, AND 200-GALLON POWER TAKE-OFF TANKERS.

2. Construction Drawings:

   F71-01 through F71-08; F75-01; F76-01; F77-01; F78-01 through F78-08; F79-01, F79-02, and F79-04.

3. OPERATION AND CARE OF THE 75-, 125-, AND 200-GALLON MODEL 40 TANKER.

A list of qualified pumpers which have been plumbed for use on Model 30 slip-on tankers is included on page 2.2.1--6 of this description. For more detail see sections 3.0, 3.2, and 3.3.

ASSEMBLY. FS Specification 5100-343a (June 1968) and FS Drawings F82-01 through F82-04, F82-06 through F82-12, and F82-15 describe the final assembly of the tank, mounting platform, reel, pumper, and related items. Prequalification is not required under this specification, but inspections and tests will be performed on the work. To date the following fire equipment suppliers have done Forest Service plastic tank assembly work:

C. E. Duggan Co., 293 E. Santa Fe Dr., Pomona, Calif. 91767
Pacific Pumpers, 1223 Western Ave., Seattle, Washington 98101
Sims Fiberglass Co., P.O. Box 36, Jefferson, Oregon 97352
Western Fire Equipment Co., 69 Main St., San Francisco, Calif. 94105

No particular Region has been designated to handle Model 30 purchases; and personnel are encouraged to handle orders or bids direct, in line with local instructions, as the need arises. The Equipment Development Center at San Dimas does not handle any fire protection agency purchases.

WRITTEN MATERIALS. Specifications and one set of construction drawings are available to all Governmental agencies. A charge will be made for construction drawing prints for non-Governmental requests. The Equipment Development Center, 444 E. Bonita Avenue, San Dimas, California 91773, is serving as custodian for the following written materials:

1. Interim Specification 5100-00342, Tank, Plastic, Fiberglass-reinforced, 75-, 125-, and 200-gallon.

2. Interim Specification 5100-00343a, Tanker, Slip-on, Plastic, capacity 75-, 125-, and 200-gallon.

3. Construction Drawings F82-01 through F82-07, plus one additional drawing (from the series F82-08 through F82-20) for the pumper selected (see page 2.2.1--6).

4. Instructions for Operation and Care of 75-, 125-, and 200-Gallon Model 30 Plastic Slip-on Tanker.

5. Forest Service Data Sheet for appropriate engine-driven pumper (specify make and model).

FIRE HOSE, FITTINGS, AND MISCELLANEOUS TOOLS AND EQUIPMENT FOR MODEL 30 TANKERS

Description	Federal Stock No.	Quantity
- FIRE HOSE AND FITTINGS -		
APPLICATOR, 48" Aluminum Extension, 45° Bend, 3/4" Male G.H. Thread on Nozzle End, 3/4" Female G.H. Thread on Inlet End	None	1
COUPLING, Hose, Double Female, 1" I.P. Thread	None	1
COUPLING, Hose, Double Male, 1" I.P. Thread	None	1
GASKET (Washer) for Hose Coupling Swivel (FS Spec. 102)		
For 3/4" size	5330-599-0776	10
For 1" size (1-1/16" to 1-7/16")	5330-720-2621	10
For 1-1/2" size (1-9/16" to 2")	5330-239-1873	5
HOSE, Fire, High-Pressure, 3/4" ID x 50'; Rocker Lug Couplings with 1" I.P. Thread (FS Spec. 185)	4720-595-1838	4
HOSE, Suction, 1" ID x 8'; Rocker Lug Couplings with 1" I.P. Thread (FS Spec. 184). For Pumpers with 1" Inlet (Cedco A10F, Edwards EBE, Pacific Pumper WA-7 and BE, and Western Fire 14X120A)	None	3
HOSE, Suction, 1-1/2" ID x 8'; Rocker Lug Couplings with 1-1/2 N.S. Thread (FS Spec. 184). For Pumpers with 1-1/2" Inlet (Edwards L-23, Pacific Pumper WX-10, Cedco or Hale HPZZ, Berkeley B1-1/2XQBS-10)	4210-889-1774	3
INCREASER, 3/4" Female G.H. Thread to 1" Male I.P. Thread	None	1
INCREASER, 1" Female I.P. Thread to 1-1/2" Male N.S. Thread	None	1
NOZZLE, Fire Hose, Fog and Solid-Stream Combination; 1" I.P. Thread Base, (R-5 FS Spec.). Complete with four tips: 3/16" Solid-Stream 3/8" Solid-Stream #3 Fog, 2-4 GPM #6 Fog, 5-7 GPM	4210-640-1892	1

FIRE HOSE, FITTINGS, AND MISCELLANEOUS TOOLS AND EQUIPMENT FOR MODEL 30 TANKERS (Cont'd)

Description	Federal Stock No.	Quantity
- FIRE HOSE AND FITTINGS (Cont'd) -		
REDUCER (Adapter), 1" Female I.P. Thread to 3/4" Male G.H. Thread	None	1
REDUCER (Adapter), 1-1/2" Female N.S. Thread to 1" Male I.P. Thread (FS Spec. 104)	4210-975-2969	1
STRAINER, Suction, Fire Hose, Globe-Shaped, 1" Female I.P. Thread. For Pumpers with 1" Inlet	None	1
STRAINER, Suction, Fire Hose, Globe-Shaped, 1-1/2" Female N.S. Thread. For Pumpers with 1-1/2" Inlet	4210-984-3460	1
TIP (NOZZLE), 1/4" Solid-Stream, 3/4" G.H. Thread (FS Spec. 5100-00244)	4210-204-3358	2
- MISCELLANEOUS TOOLS AND EQUIPMENT -		
BOX, Accessory	None	1
CONTAINER, Pumper Maintenance Instruction	None	1
GAGE, Feeler, Spark Plug	5210-189-9538	1
INSTRUCTIONS, Pumper Maintenance, include the following pamphlets:		
Engine Instruction Manual (mfrs.)	None	1
Pumper Instruction Manual (mfrs.)	None	1
Pumper Parts Manual (mfrs.)	None	1
Instructions for Operation and Care of 75-, 125-, and 200-Gallon Model 30 Plastic Slip-On Tanker (SDEDC)	None	1
PAIL, Canvas	8465-582-1277	1
PLUG, Spark, A.C. No. C86 Commercial or Autolite No. BT-8 or Equal. (For Wisconsin BKND and AENLD; and Briggs & Stratton 80332 Engines)	2920-540-8352	1
PLUG, Spark, A.C. No. GC46 or Autolite A7, or Equal. (For Briggs & Stratton 23A-FB, 243434, and 142451 Engines)	2920-540-8342	1
ROPE, Starter	2990-294-0934	1

FIRE HOSE, FITTINGS, AND MISCELLANEOUS TOOLS AND EQUIPMENT FOR MODEL 30 TANKERS (Cont'd)

Description	Federal Stock No.	Quantity
- MISCELLANEOUS TOOLS AND EQUIPMENT (Cont'd) -		
WRENCH, Open End, 13/16" x 7/8"	5210-184-8559	1
WRENCH, Spanner, 1" and 1-1/2" Combination (FS Spec. 5100-101)	5210-596-1426	1

INTEGRAL TANKER CONSTRUCTION

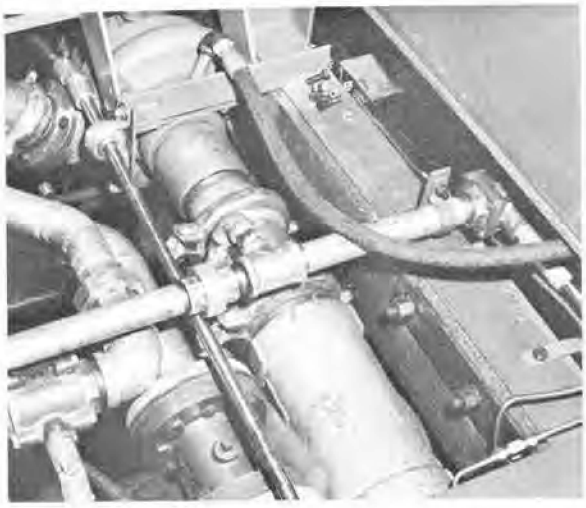
Model 40 . . . . . 75-, 125-, & 200-Gallon Tank
Model 60 . . . . . 500-Gallon Tank
Model 56 . . . . . 300-Gallon Tank

2.3 - DESIGN CONSIDERATION. The design considerations for the Model 20 tanker sizes (see section 2.1) were generally used in the early construction of the Model 40 PTO tankers. The "preferred tanker operator position," just behind the driver's cab door, was used. This makes for a more efficient initial attac by a small crew. In the 75-, 125-, and 200-gallon sizes, tankers are lighter and less expensive than the metal slip-ons. However, the reverse is true of the 300-gallon sizes.

The Model 60 tanker is considered separately. It is described in detail in section 2.3.2.

PTO INSTALLATIONS.

The selection of a PTO tanker assumes that careful consideration has been given to the vehicle to be used. While the installation of the pump drive assembly is rather simple in the Model 40, this is not true of the Models 56 and 60. The photograph shows the centrifugal pump (upper right) and the related plumbing as permanently installed in the Model 60.



A detailed explanation follows for each Model PTO system used in FS practice. Actually, most of these models are in operation in the California Region.

MODEL 40 POWER TAKE-OFF TANKER

Tank Sizes: . . . . . 75-, 125-, and 200-gallon
Crew Size: . . . . . 1- or 2-man
Tanker Performance: . . . . . 70 gpm @ 200 psi
Style: . . . . . Integral unit; all-metal construction
Standard: . . . . . California Region; USDA - Forest Service

2.3.1 - GENERAL. The Model 40 Power Take-Off Tanker is provided in three tank sizes - 75-, 125-, and 200-gallon. The vehicle engine, or pump power source, is already running upon arrival at the fire. This insures fast action at the fire. The operator can engage the pump before leaving the cab and can reach all controls easily.

The driver has unrestricted visibility with the hose basket installation.

The low silhouette tanker shown above as a 200-gallon tanker with live hose basket has a well-balanced load and good road-handling characteristics.

All water accessories and handtools are readily accessible.

This integral tanker was designed primarily for initial attack on small fires by a one- or two-man crew.

If the fire load and length of fire season warrant an integral tanker design, this power take-off unit is a logical selection since it is somewhat lighter and less expensive than comparable slip-on types.

Tanker Weights and Truck Options

Tank Size (Gallons)	Added Weight*		Suggested Truck GVW's	
	Dry	Wet	4x2	4x4
75	2,260	2,870	6,500	7,100
125	2,290	3,340	7,300	7,600
200	2,500	4,170	8,500	9,000

*Provides for the truck body, water load, typical accessories and equipment, and a two-man crew. The curb weight of the basic vehicle is not represented in these figures.

Dimensions of Unit in Vehicle Bed

Tank Size (Gallons)	Overall Assembly With Basket**		
	Width	Length	Height
75	47-1/2"	46"	28"
125	47-1/2	50	32
200	47-1/2	65	32

**To top of hose basket, but excluding filler spout and cap.

Tank Description

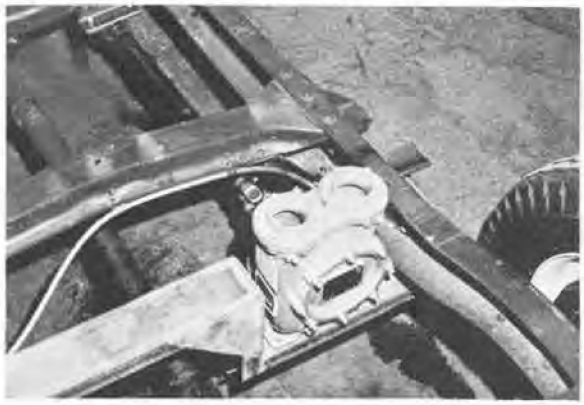
- 14-gauge welded sheet-metal construction
- Full tank top access
- 4" ID lightweight filler spout cap
- Hot dip galvanize tank coating
- 1 1/2" N.P. Thread plumbing connection.

Reel or Hose Basket Option: If the standard Forest Service reel is selected, 250' of 3/4" ID high-pressure rubber hose may be used. If the hose basket is preferred, it can be equipped with 200' of 1" single cotton-synthetic jacket, lined hose. A few forestry agencies prefer double-jacketed hose. (See section 2.6.1 and 2.6.2.)

The hose basket is provided in two sizes. The 75-gallon size is 27-3/8" x 43-1/2" x 13", and the 125/200-gallon size is 44-5/8" x 44-5/8" x 8", inside dimensions.

A tubular rim provides a smooth, rounded edge for hose protection. All hose baskets are equipped with duckboard in the bottom. A fire-resistant cover is also provided in the drawings. A four-way hose-roller is essential with baskets.

Color of tank, reel or basket, and protective cage . . . . . green



POWER TAKE-OFF. The vehicle engine is used to drive the pump in this power take-off assembly. A DANA Spicer AA type is generally used to fit the particular truck transmission supplied.

PUMP. A pump capable of 70 gpm @ 200 psi at a truck engine speed of 2,600 rpm is specified for any tank size used. A Gorman-Rupp Model 02F1-GR self-priming, single-stage, centrifugal pump has been used satisfactorily in this assignment. Forest Service hydraulic tests rate this bare pump at 132 gpm @ 200 psi driven at an engine rpm of 2,500.

This pumper performance is reduced somewhat by plumbing. The following is representative performance at the overboard hose connection:

PSI	50	100	150	200
GPM	80	79	75	70

The flow rates are restricted to these values through the plumbing system plus 24 feet of 1-1/2" suction hose at a 2' lift and a vehicle engine speed of 2,500 rpm.

At lower elevations, the pump is capable of developing a dry suction lift of 15 feet provided the pump has priming water in it.

PLUMBING. A 2 1/2" hydrant cap offers access with a spanner wrench. A 16-gauge wire mesh stainless steel strainer screens water entering the pump.

The cleanout trap and the flexible plumbing lines running to and from the tank to the controls are protected by a light metal frame guard.

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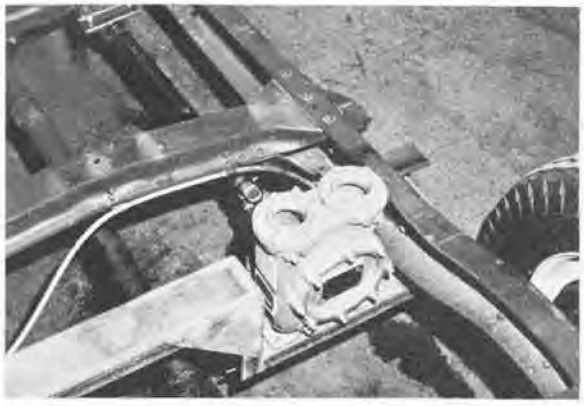

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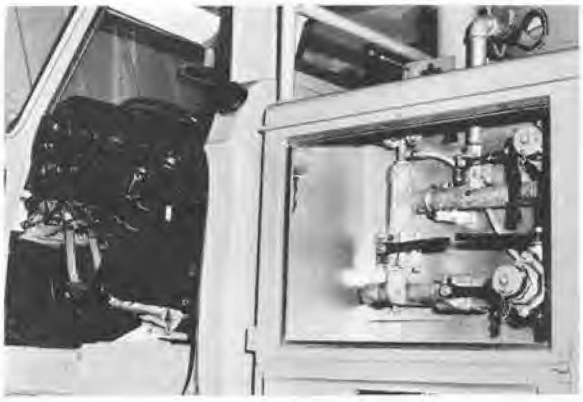

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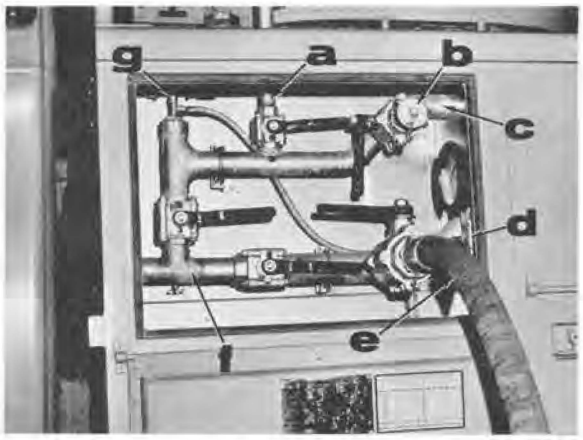

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3. OPERATION AND CARE OF THE 75-, 125-, AND 200-GALLON MODEL 40 TANKER.

3. MISCELLANEOUS TOOLS & EQUIPMENT FOR MODEL 60 ENGINE

Item Description	Federal Stock No.	Quan. Min	Quan. Max	Compartment
BAR, Wrecking, 3/4" x 36"	5120-242-0762	1	1	G
BOX, Tool, Steel (19" x 7" x 7")	5140-331-5496	1	1	C
(Box, Tool - Contents):				
Chisel, Cold (5" x 3/8")	5110-242-3457	1	1	
File, Hand Knife (Smooth Cut Style C 6")	5110-203-4552	1	1	
File, Hand, Mill (Regular, Smooth Cut Style 12")	5110-203-4645	1	3	
File, Hand, Mill (Regular, Bastard Cut, 12")	5110-242-5386	1		
File, Handle (Wood, Small)	5110-263-0342	1	1	
File, Handle (Wood, Large)	5110-263-0341	2	4	
Pliers, Slip Joint (Hose Clamp; 7-5/8")	5120-537-3375	1	1	
Screwdriver, Combination (1/4" flat tip x No. 2 cross tip)	5120-301-1076	1	1	
Screwdriver, Flat Tip (10"x3/8")	5120-293-3309	1	1	
Wrench, Open End (Adjustable 3/4" x 6")	5120-264-3795	1	1	
Wrench, Open End (Fixed; Double Head 3/4" x 7/8")	5120-240-5609	1	1	
CUTTER, Bolt	5110-224-7057	1	1	H
EXTINGUISHER, Fire (Dry Chemical) 5 lb.	Minimum	1	2	Cab
GEAR, Personal Items	-			A,B or F
GOGGLES, Industrial	4240-01-055-2310	6	6	D
HAMMER, Ball-peen, 1/2 lb.	5120-242-3913	1	1	E
KIT, First Aid (10-unit #2) w/Snake-bite kit.	6545-00-656-1093	1	1	D
KNAPSACK *	8465-205-3493	2	6	B
LANTERN, Electric	6230-00-500-0523	0	1	D
OIL, Motor (quart)	-	1	2	E
PACKBOARD, Plywood	-	0	8	O

* Does not include knapsacks for personal gear

3. MISCELLANEOUS TOOLS & EQUIPMENT FOR MODEL 60 ENGINE (Cont'd)

Item Description	Federal Stock No.	Quan Min	Quan Max	Compartment
PAIL, Nylon 3 gal. collapsable	8465-01-128-6928	0	1	1
PLIERS, Side Cutter (lineman's) 8"	5120-756-1156	1	1	E
RATION, Combat, Individual	8970-00-577-4513	6	12	A or F
ROPE, Nylon, 1/2" (100')	-	1	1	D
SCREWDRIVER, Flat Tip (8" x 3/16")	5120-988-6489	1	1	E
WRENCH, Open End (Adjustable 1-5/16" x 12")	5120-264-3796	1	1	E
WRENCH, Pipe, Adjustable (2-1/2" x 24")	5120-277-1462	1	1	G
WRENCH, Pipe, Adjustable (2" x 18")	5120-277-1461	1	1	G

4. FIRELINE HAND TOOLS FOR MODEL 60 ENGINE

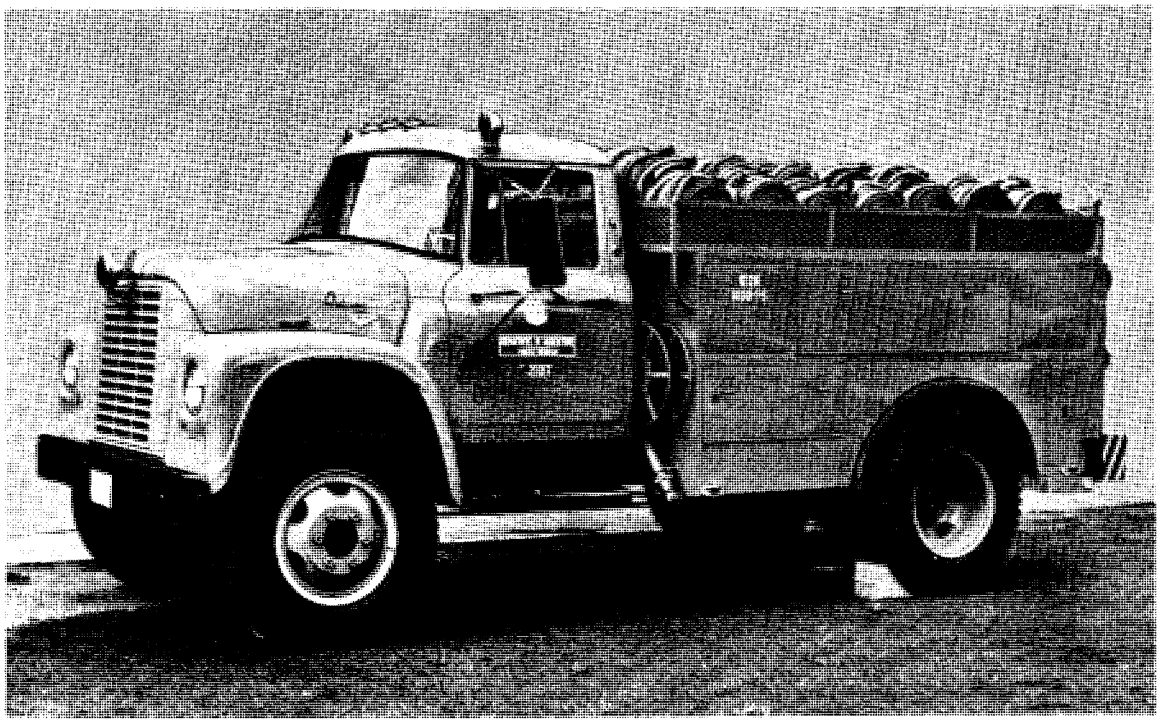
Item Description	Federal Stock No.	Quan. Min	Quan. Max	Compartment
AXE, DB, Cruiser; 2-1/2 lb., 27" handle (FS Spec. 9: Type C)	5110-00-293-3300	0	2	H
CANTEEN, Water, 4 qt. (FS Spec. 5100-0083)	8465-00-082-3054	5	5	I
FUSEE, Backfiring, 10-min. (FS Spec. 5100-360a)	1370-00-294-1279	0	24	J
TORCH, Drip Backfire	-	0	1	
HAMMER (Sledge), Stoneworker's 8 lb., 32" Handle	5120-187-1044	1	1	H
HEADLAMP, Electirc	6230-00-643-3562	5	6	D
(HEADLAMP) BATTERIES, Dry, Size D	6135-00-835-7211	24	24	D
HOOK, Brush, 10-1/4" blade, 36" handle (FS Spec. 5100-00180a)	3750-00-240-3085	2	4	H
MCLEOD TOOL, (FS Spec. 5100-353)	4210-00-203-3512	2	3	G
OUTFIT, Back-pack Pump, Neoprene Coated (FS Spec. 5100-257)	4320-00-289-8912	2	3	D
PULASKI TOOL (FS Spec. 5100-355)	5120-00-293-3467	3	4*	H
SAW, Two-man Crosscut, felling w/handles, 6"	5110-062-6625	0	1	N
or				
SAW, Power	-	0	1	A or B
FUEL, Power Saw Mix - 3 gal.	-	0	1	E
(SAW) OIL, 1 qt. (For Power Saw)	-	0	2	E
SHOVEL, Hand, Forest Fire Fighting Size 1 (FS Spec. 5100-00326)	5120-00-965-0609	3	5	G
WEDGE, Timber, Wood, Plastic, 3" wide, 11" long	5510-00-640-9237	2	4	D
SHELTER, Fire w/case	4240-01-062-8226	6	6	CAB

5. VEHICLE ACCESSORIES, EQUIPMENT, AND TOOLS FOR MODEL 60 ENGINE

Item Description	Federal Stock No.	Quan. Min	Quan. Max	Compartment
BLOCK, Chock	-	2	2	E & J
CHAINS, Snow & Mud Tire (set)	-	0	1	E & J
CHAIN, Tow, 3/8" x 20'	4010-00-171-4427	1	1	E
GAUGE, Tire Pressure, to 130 lbs. 12-1/2"	4910-204-3170	1	1	Cab
JACK, Hydraulic, Hand, w/handle, 8-ton; 11-1/ to 22-1/8" rise	5120-061-0728	1	1	E
REFLECTOR, Warning	-	2	2	-
WRENCH, Lug, Wheel	-	1	1	D
Oil, Transmission, Quart	-	1	1	E
Oil, PTO, 50 wt. Mineral, Quart	-	1	1	E
Oil, Pump, 60 wt. Mineral, Quart	-	1	1	E

SPECIAL TANKER CONSTRUCTION

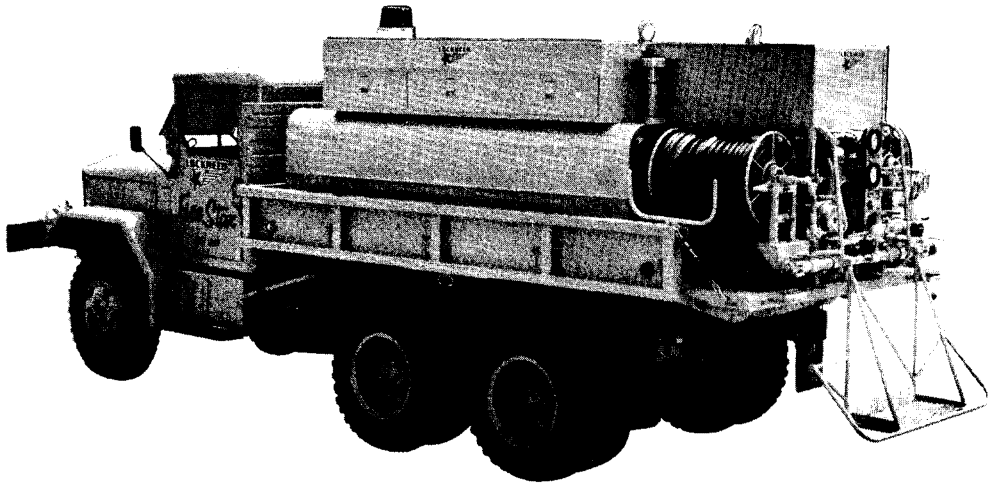
Over 500 gallons, nonstandard use



2.4 - SPECIAL CONSTRUCTION ORDERS. The tanker standardization projects financed Service-wide and by the California Region during the 1960 decade defined work on slip-on and integral units 50 through 500 gallons, respectively. The Equipment Development Center at San Dimas has given limited assistance in the design and construction of a few larger units. Assistance to the Regions and Forests is sharply limited for special tankers not included in the above model designations.

LOCKHEED LASV-17A SLIP-ON TANKER

Tank Size: 1,000-gallon
Crew Size: 2-man
Pumper Performance: . . . . . .85 gpm @ 175 psi
Style: . . . . . Slip-on, end-mounted, all-metal construction
Standard: . . . . . Non-standard

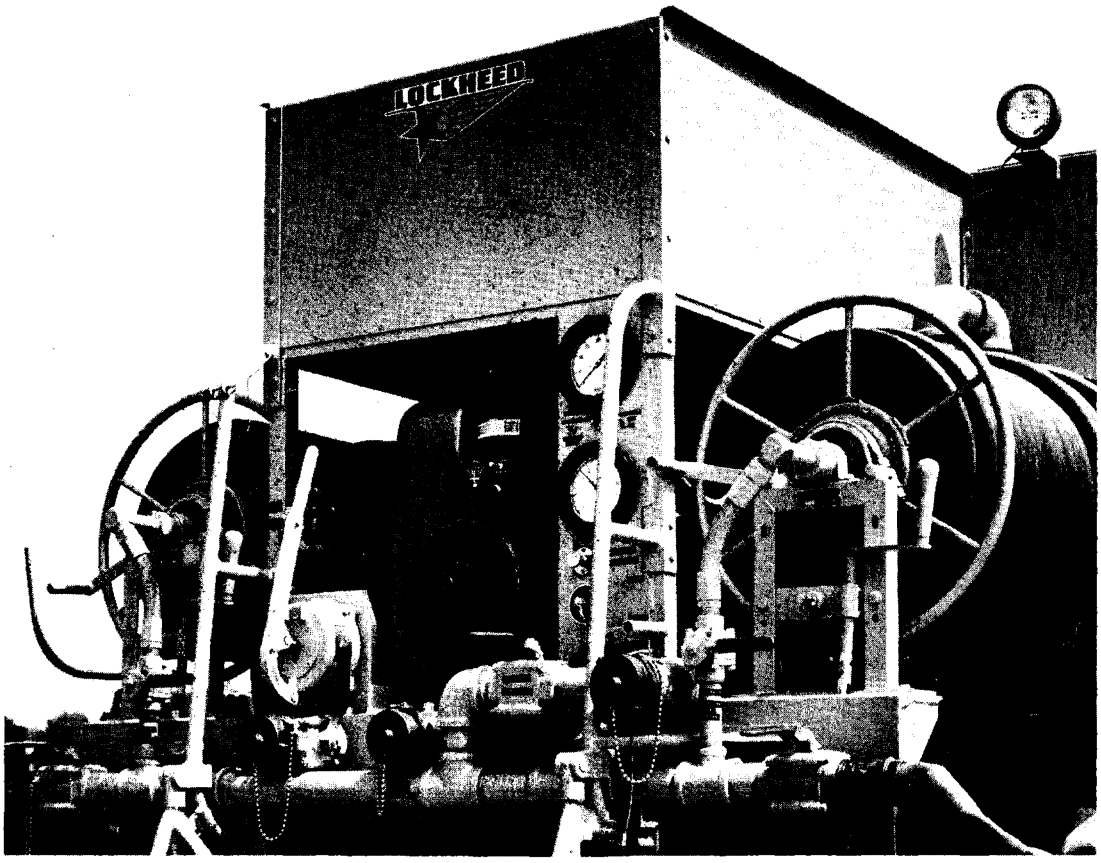


GENERAL. The Lockheed FireStar™ is a completely self-contained fire-fighting system that can be quickly installed on an unmodified military 6 x 6 cargo truck. In combination with the truck, it provides a fully effective fire unit capable of operating in the difficult terrain encountered in wildland areas that are inaccessible to conventional, metropolitan fire apparatus.

The FireStar™ is accommodated wholly within the standard truck body and is fitted with motion restraints; no modifications of the truck are required. It incorporates its own pumper fuel supply, electrical power, working lights, service platform, and equipment storage provisions.

The 1000-gallon tank is connected to an engine-driven, single-stage centrifugal pump with a delivery capability of 39 gpm @ 250 psi to 122 gpm @ 50 psi. The simple piping system permits water to be pumped from tank-to-fire, draft-to-fire, or draft-to-tank, and also provides for hydrant filling of the tank.

CONTROLS. The controls shown are similar to conventional fire-fighting apparatus and are grouped with the necessary gauges and valving in an easily accessible location at the rear of the slip-on.



Dimensions overall: Length - 180 x width - 88 x height 63-in.

Weight: The following calculated weights include the two reels, booster hose, suction hose, representative pumper, and the handrail and platform.

Dry - 2,100 lb. Wet - 10,400 lb.

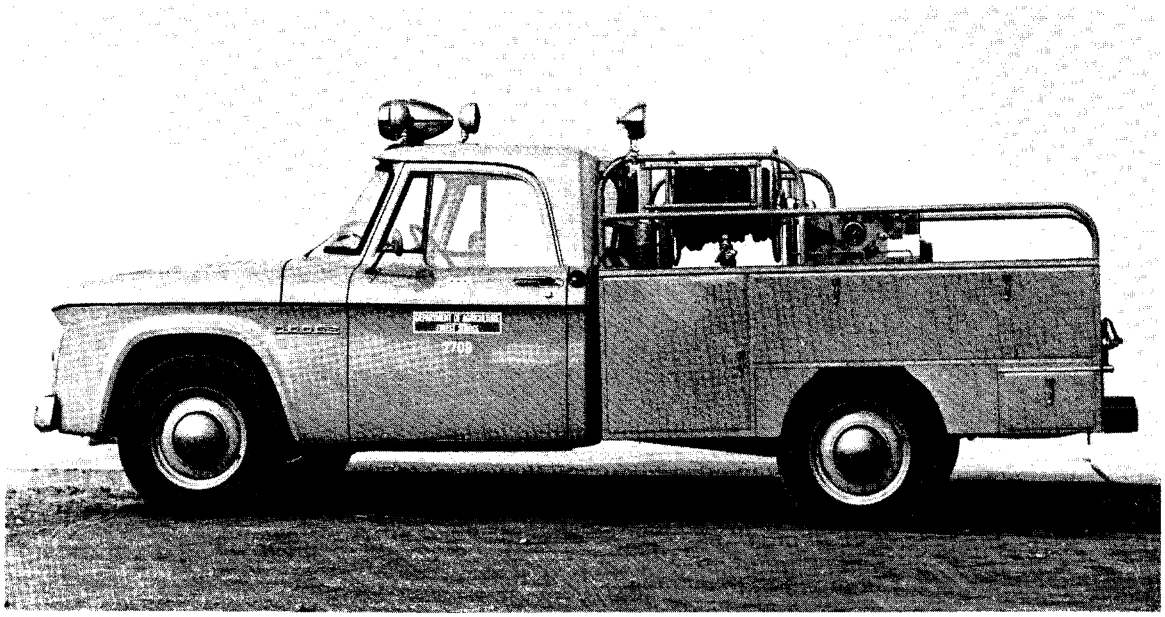
TRUCK. The FireStar(TM) unit was designed to slip on a 2½-ton standard military 6 x 6 (M35 shown). The unit can also be used with the 5-ton M54.

AVAILABILITY. The Lockheed LASV-17A FireStar(TM) Slip-on Tanker is a single-source item designed and constructed by the Lockheed Aircraft Service Co., a division of Lockheed Aircraft Corporation, P.O. Box 33, Ontario, California 91761 (Telephone: 714/984-1234).

Written materials and technical details should be requested directly from the company.

PICKUP SERVICE BODY

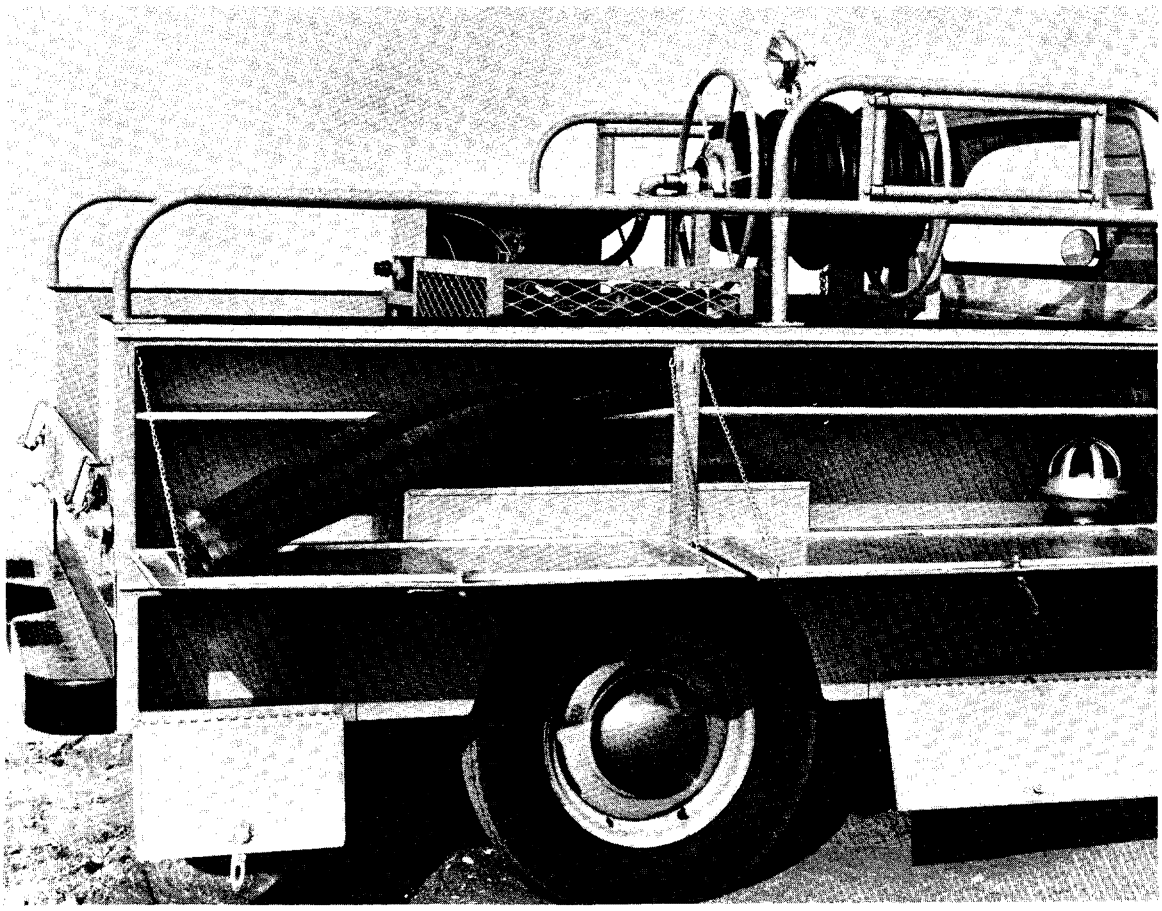
Body sizes: . . . . . 7-1/2' and 9'
Crew size: . . . . . 1 or 2 men in cab
Pickup size: . . . . . 3/4- and 1-ton
Standard: . . . . . California Region, USDA - Forest Service



2.5.1 - R-5 LOW PROFILE TANKER BODY. This low profile service body is for use in place of the standard 3/4-ton and 1-ton pickup bodies. The full-size pickup inner bed width will accommodate a slip-on tanker or the PTO unit. Weathertight side compartments are provided to protect tools, parts, supplies, and personal belongings such as clothing and sleeping bags from weather, dust damage, and pilferage. An enclosed shelf, the full length of the body on the curb side, is provided for storage of suction hose. The rear half of the bed may be used for cargo with the slip-on or PTO unit installed. It may be used as a full-size pickup bed when the slip-on is removed. The low position of the side compartments permits easy access from all sides to the interior of the standard-size body.

When the body is used on the Model 40 tanker, the forward compartment on the driver's side is used for the control panel.

Requirements for fittings, accessories, and fireline tools vary so much from Region to Region that no interior compartment fixtures have been provided.



This body is designed for fireline use and for unimproved forest road travel. Since these units will be subject to abnormal stresses, vibration, and other related operational abuse, the best commercial grade materials and good engineering practices are used throughout construction and assembly to insure a useful life expectancy of 12 years.

The low profile service body is of welded steel unitized construction with compartments of standard pickup bed height on both sides of the bed. The floor is of channeled steel with full width steel cross supports. The cross supports have jig-punched or drilled mounting holes to allow the shifting of mounts in or out, depending on truck frame design, so the body may be easily transferred from one truck to another. Wheel wells built within the body permit the top circumference of the tire to travel upward into the wheel well housing. This internal wheel housing allows low overall height without loss of storage area. All compartment doors have hasp-type door latches which may be padlocked.

AVAILABILITY. The Regional Administrative Office of the California Region (5) has been issuing annual construction bids about September 1. Delivery is usually made the following spring or summer. Other Regions and other Federal agencies have been processing their orders through R-5. Construction costs may vary from year to year.

WRITTEN MATERIALS. The specification and one set of construction drawings are available to all Government agencies. A charge will be made to non-Governmental agencies. Requests should be directed to the Regional Forester, California Region, for the current specification or construction drawings. Design inquiries may be directed to the Equipment Development Center, 444 E. Bonita Ave., San Dimas, California 91773.

Written materials include:

1. Specification 5100-R5-02 for LOW PROFILE TANKER BODY (7-1/2' and 9')

2. Construction drawings:

   7-1/2' body - Drawing No. F79-01
   9' body - Drawing No. F79-02

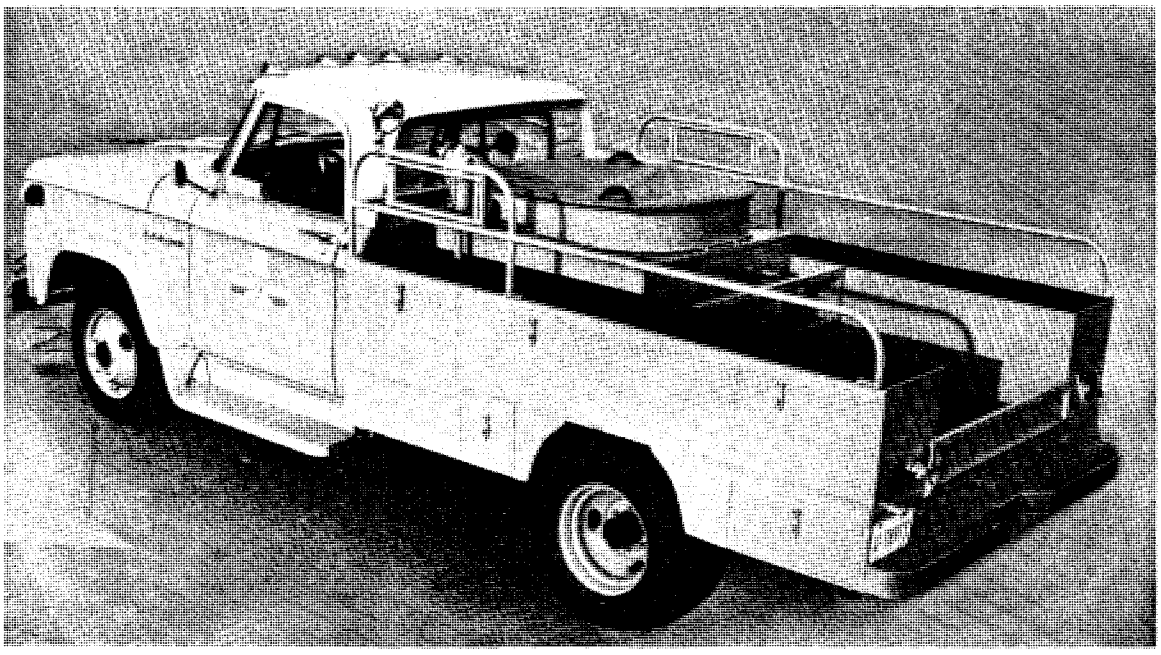
The following firms have furnished low profile bodies under bid:

C.C. Douglas Mfg. and Sales
231 21st Street
Bakersfield, California 93305
(805) 324-6341

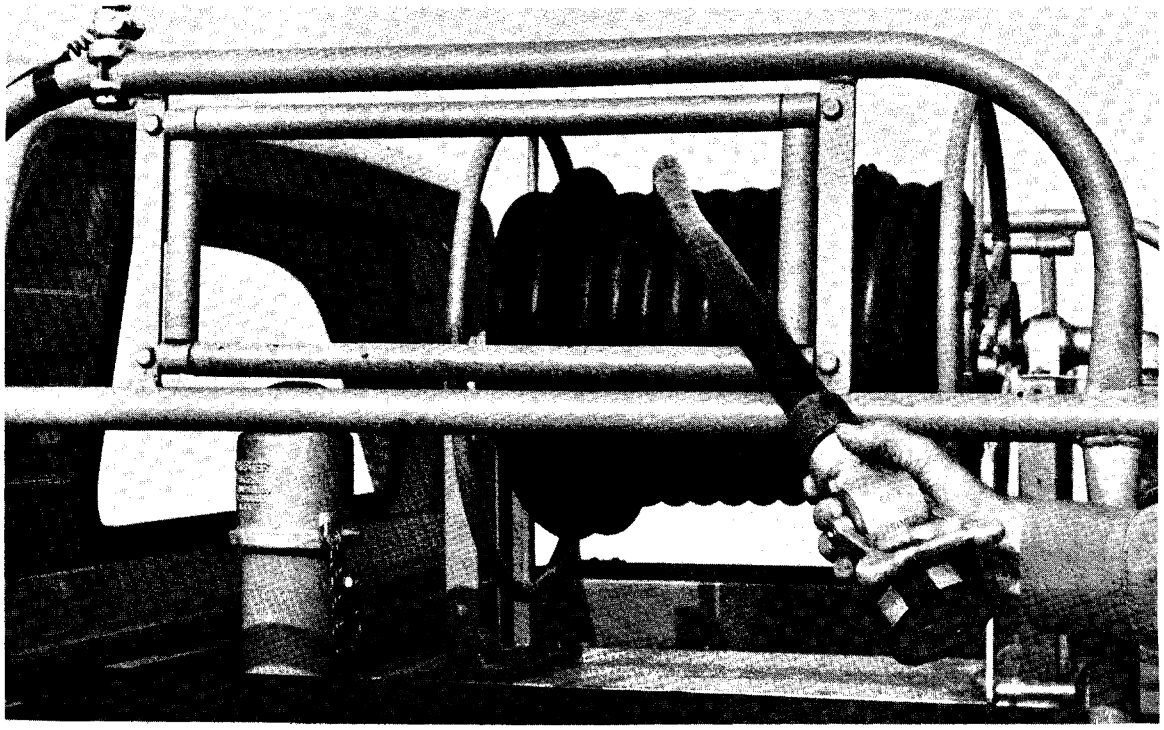
Wilhelmsen Sheet Metal
7325 Madison Ave.
Paramount, California 90723
(213) 774-2275

2.5.2 - GUARDRAILS. Pickups used to regularly transport personnel shall have guardrails sufficiently high and strong to prevent falls (see HSC 3.14(1)C). Guardrails have been designed for the low silhouette service bodies in 7-1/2' and 9' sizes.

WRITTEN MATERIALS. See Construction Drawing F79-04.



2.5.3 - HOSE ROLLER GUIDE. A four-way roller guide assembly is provided on each side of the hose reel or basket. This guides the hose as it pays off the reel or out of the basket, keeps couplings away from the tanker body, and makes initial attack simpler for one or two men. It does not matter if the attack is up a steep slope, down a fill slope, or in front or in back of the unit. The hose can pay out from a fixed location. The roller guides also tend to keep loose coils from getting under truck wheels.



WRITTEN MATERIALS. The Equipment Development Center, 444 E. Bonita Ave., San Dimas, California 91773, will furnish a construction drawing of the guardrails for Low Profile Tanker Bodies, Drawing F79-04.

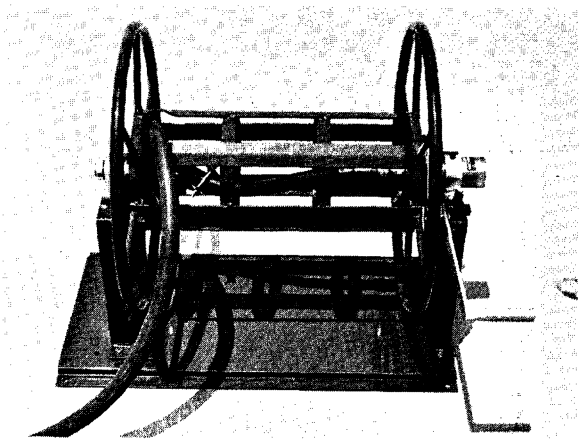
AVAILABILITY. The four-way hose roller guide assembly is available from American Reeling Devices, Inc., 9850 Rush Street, South El Monte, California 91733.

REELS AND BASKETS

2.6 - GENERAL. A high percentage of man-caused fires start along roads or areas accessible to fire tankers. Most of these fire starts are within reach of a charged, live fire hose. The hose may be either hard line on a reel or soft 1" hose coiled in a basket. For 1- and 2-man crews this becomes a logical, effective means for initial attacks.

2.6.1 - LIVE HOSE REEL. The Forest Service has standardized the design of reels used on its tanker models. These reels have proven to be rugged and economical and offer maximum interchangeability between different models and different tank sizes of the same model. The dimensions are so critical on some slip-ons, such as the Models 10 and 30, that oversize dimensions cannot be used.

The reels of Tanker Models 10 through 60 are positioned with the reel axis parallel to the sides of the fire truck. This permits a 180-degree sweep of the hose line on either side of the tanker.



DESCRIPTION. Six different sizes of the Forest Service live hose reel design are offered to accommodate the desired hose length. A 300- or 600-psi working pressure option is described, but in practice usually only the 600-psi rating is furnished.

The reel is composed of a skeleton slot drum between two outer handwheels. A revolving pipe swivel joint with the necessary pipe and couplings provides water through the center of the drum to the fire hose. A self-aligning pillow block bearing is used at the opposite end, along with the necessary mounting brackets.

BRAKE. An adjustable handbrake prevents overrun and the resultant tangling of hose. A combination shaft bearing and friction brake is also available. An adjustment for drag tension and take-up for wear is provided.

CRANK REWIND. The rewind mechanism is an option. Both gear and gear-and-chain combination drives have been used. Rewind cranks are specified on Forest Service tankers carrying 300 gallons of water, or more (Models 50, 56 and 60). An electric rewind is not offered in the present drawings, but this feature could be provided without difficulty.

SWIVEL JOINT. Revolving joints are either 1" Chiksan style No. 20, with mounting bracket, or Metal Masters Model 101, with mounting bracket, or equal, to conform to the minimum specified working pressures of either 300 or 600 psi.

COLOR OPTIONS. . . . . Red or Green

SIZES.

Tanker Model	Reel Size	Number of Reels	Manual Crank Rewind	Drawing No. Showing Brake Handle & Revolving Joint Location	Brake Handle Length from Center of Reel (Inches)	EDC Stock Number
10	6	1	No	F72-01*	----	F58-016
20	5	1	No	F73-09	16 to 24	F73-093
30	5	1	No	F82-01	12 to 14	F82-017
40**	5	1	No	F78-07	16 to 24	F78-073
50	3	1	Yes	F21-01 & F58-01 Right-hand reel	Not more than 10-1/2	F58-013 Right-hand reel
56	3	2	Yes	F42-01 & F58-01 1 Right-hand reel 1 Left-hand reel	Not more than 10-1/2	1-F53-013 RH reel 1-F53-013 LH reel
60	3	2	Yes	F81-39	Not more than 10-1/2	F81-391 (right side) F81-392 (left side)

*Must use bronze pillow block bearing with brake mechanism
**Basket is standard equipment; hose reel, optional

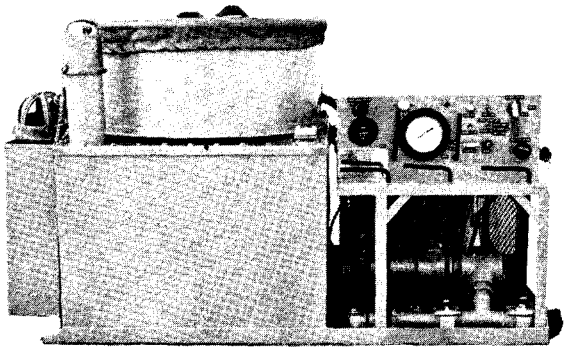
WRITTEN MATERIALS. The following materials are available from the Equipment Development Center, 444 E. Bonita Ave., San Dimas, California 91773.

1. Interim Specification 5100-00348 for LIVE HOSE REEL, 300-600 psi WORKING PRESSURE WITH BRAKE.

2. Construction Drawings F58-01 and F58-02.

2.6.2 - LIVE HOSE BASKET. Some firemen prefer baskets instead of reels. The basket is optional for the Model 20 tanker and standard for the Model 40. The hose basket mounts on the tank top and offers a low silhouette which gives improved visibility out the rear window.

One-inch cotton-synthetic lined hose is coiled carefully in the basket under some pressure. The pressurized hose pays out readily to the fireline.



A round, tubular rim is provided at the top of the basket to avoid hose and coupling damage. A fire-resistant cover is provided for hose protection (see typical installation on a 125-Gallon Model 20 Tanker). Every hose basket is equipped with a wooden duckboard. Four-way hose rollers are essential on both sides of the basket, as shown in sections 2.5.2 and 2.5.3.

3/4" ID vs. 1" ID HOSE. Hose weights and friction loss factors are important considerations in the choice of a reel versus a hose basket. The following table points out these factors:

WEIGHT AND FRICTION LOSS COMPARISON

(100' lengths coupled each 50')

Type of Hose	ID	Working Pressure	Dry Weight	Gallons Water	Weight Water	Total Weight	Friction Loss Pounds/100'*
Rubber-covered	3/4"	425	47	2.3	19	66	93
Rubber-covered	1"	--	53	4.1	34	87	22
Cotton-synthetic lined	1"	450	22	4.1	34	56	22

*28 gpm flow through a 5/16" tip @ 100-psi nozzle pressure.

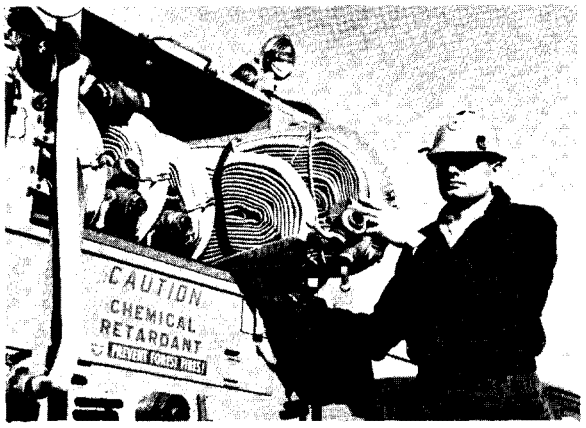
The above figures make it possible to compare dry hose weights, the weight of the water involved, and the total weight the fireman must carry. (Note the dramatic reduction in friction loss in going from 3/4" to 1" ID hose.)

The higher initial cost of 3/4" high-pressure rubber-covered hose must also be considered. However, it will have a longer life expectancy, is less subject to damage, and needs less care.

WRITTEN MATERIALS. The following construction drawings are available from the Equipment Development Center, 444 E. Bonita Ave., San Dimas, California 91773:

1. "Hose Basket and Duck Board for the 75-gallon Tank" F71-06
2. "Hose Basket and Duck Board for the 125- and 200-gallon Tank" . . F71-05
3. "Hose Basket Cover for the 125- and 200-gallon Tank" F71-07

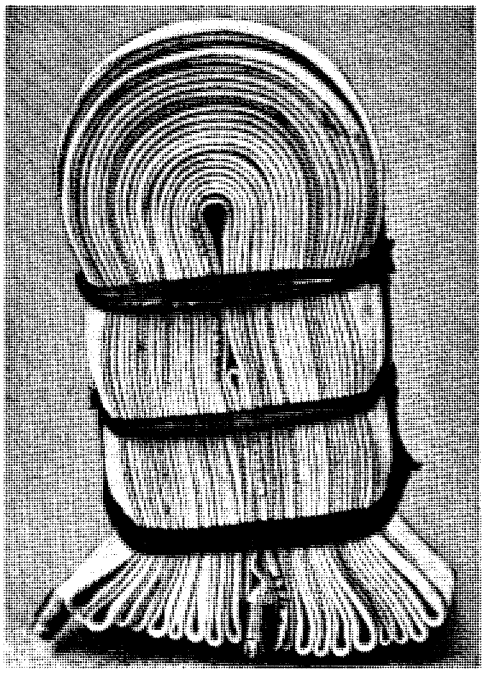
PACKS AND TRAYS FOR FOLDED HOSE



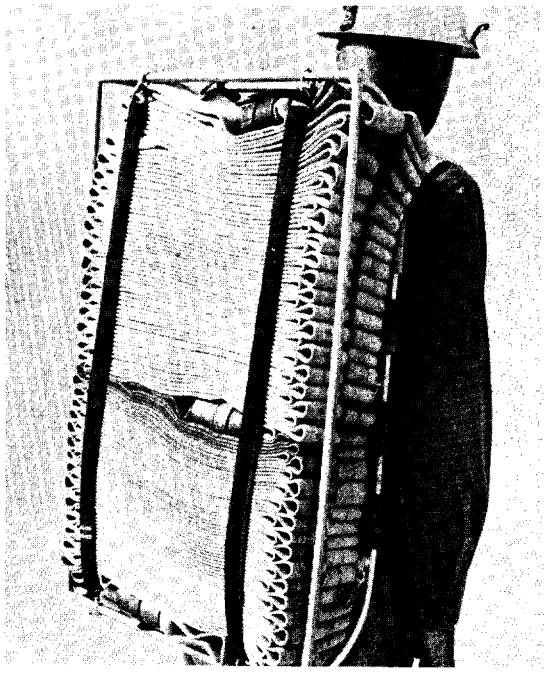
2.7 - GENERAL. Adequate hose compartments and bins have been provided on the Model 50 and 60 crew tankers. Long hose lays are common on large fires where water can be used effectively. Many fires occur beyond the reach of a live hose reel line. Tanker crews that drill and handle hose rapidly and efficiently usually use some form of hose pack.

2.7.1 - HOSE PACKS. The availability of new synthetic hose fibers and lightweight alloys has produced dramatic weight reductions. Brass is giving way to light alloys and to space-age plastics. A study of hose-laying techniques in 1965 and 1966 indicated there was no standard or generally preferred hose roll, bundle, or packboard (FS-Equip Tips, 1966). However, progressive tanker crews were using many effective ways and various packs to get hose out and charged in the shortest time.

The Cleveland National Forest (R-5) is using a flat plywood board 18" x 36" equipped with carrying straps. Three large hooks are spaced down each side. Two layers of accordion-folded hose are held in place by bungee cord and tire tube bands. Hose pays out from bottom-center. Capacity is 150' to 200' of 1-1/2" cotton-synthetic lined hose. Approximate weight loaded is 65 pounds.



The San Bernardino National Forest (R-5) is using a similar pack. Several different surplus models and Clack packboards are in use. A double layer of hose is held in place to feed out consistently under tire tube bands or web straps. Approximate weight, again, is about 65 pounds.

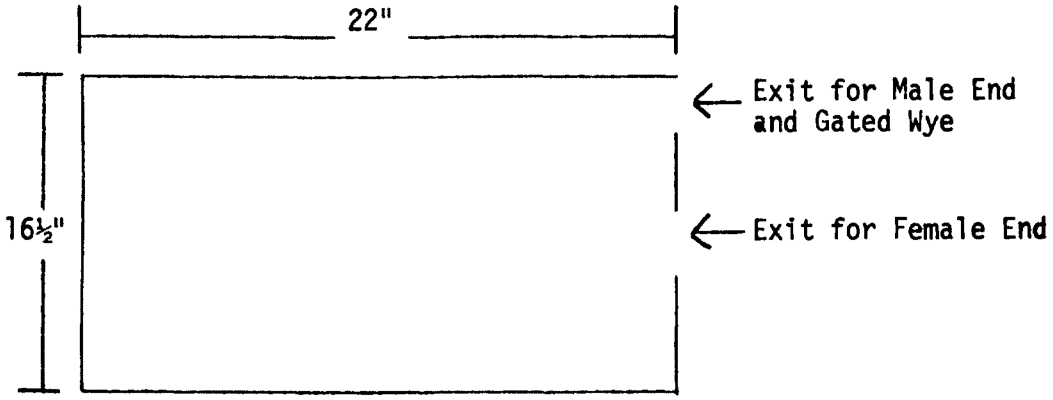


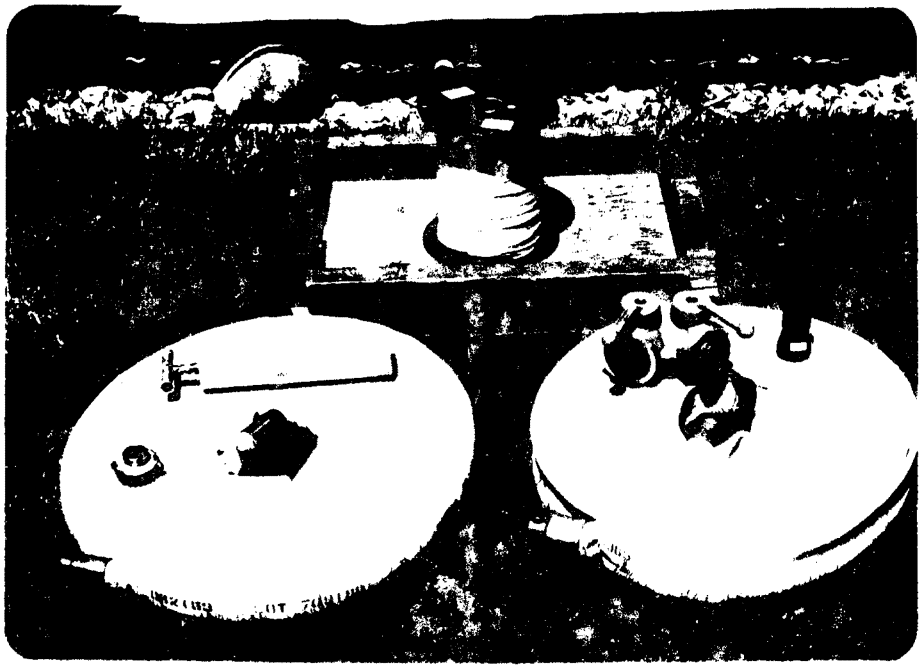
The Ely Service Center, R-9, uses the "All Purpose Pack Frame." The equipment measures 30" x 20" x 6" and weighs 7 pounds, empty. The rigid frame is built from 1/2" OD #20 wall seamless metal tubing. This frame capacity is 400' of 1-1/2" linen or 600' of 1". A hose-folding jig frame is used to fold and pack this unit. Total weight is 72 to 75 pounds (FS-FC Notes, 1940, Jan. and Oct.).

GANSNER PROGRESSIVE HOSE PACK. Several adaptions of the Cleveland National Forest's hose pack have been devised. The Gansner Progressive Hose Pack, developed on the Plumas National Forest, requires no packboard using the stiffness of the hose itself for support. The shoulder straps are loops of hose. The packing time is twenty minutes. This ingenious system is detailed in the following pages.

1. Equipment Needs Per Pack

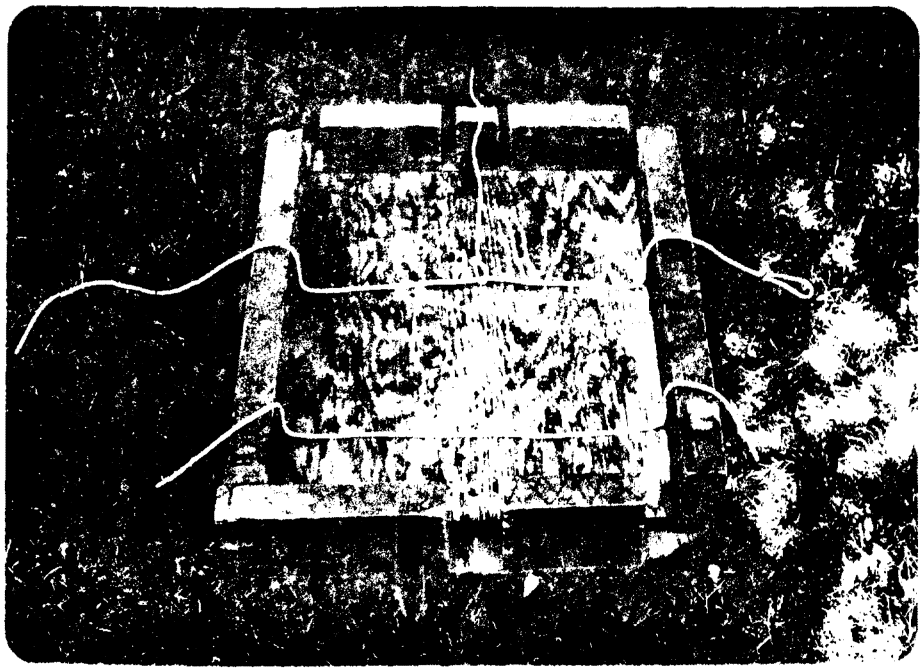
   a. 1 100' section 1½" CJRL
   b. 1 100' section 1" CJRL
   c. 1 Gated Wye 1½"
   d. 1 Reducer 1½" N.S. to 1" I.P.
   e. 1 Nozzle (Twist Type) 1"
   f. Nylon Parachute Cord (Cut to length, available from Fire Warehouse)
   g. 1 Mark III Primer (To deflate hose to aid packing ease)
   h. Hose Packing Frame



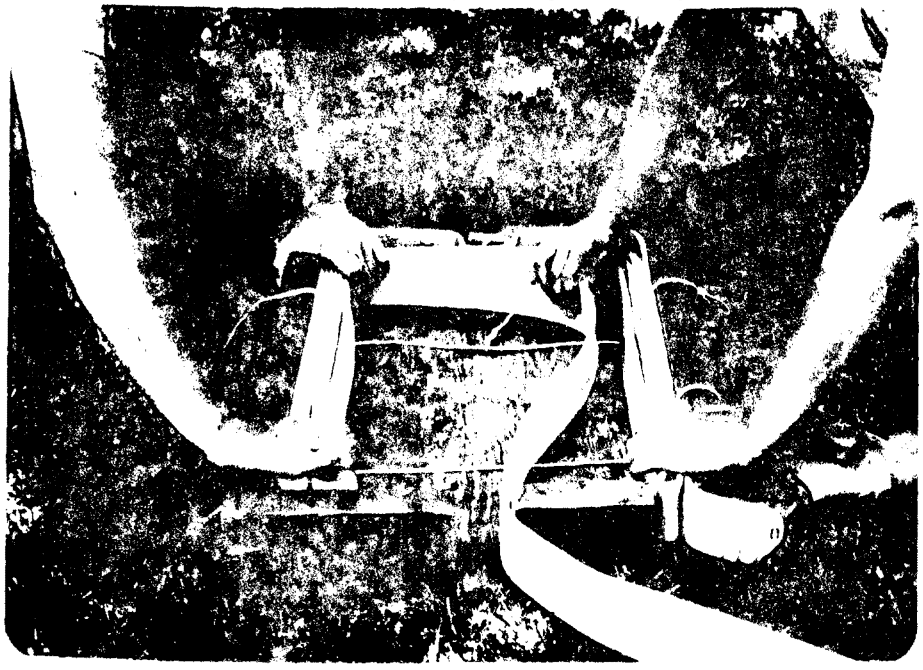


2. Packing Instructions and Procedures

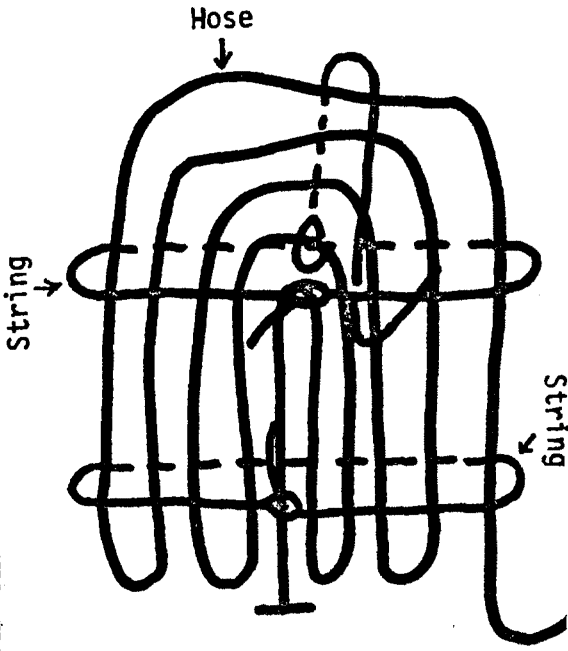
a. Place packing frame and align cord as shown in photo below:



b. Deflate 1½" CJRL with aid of Mark III primer. Place hose in packing frame with gated wye on side against box as shown in photo below and continue horseshoe packing technique:

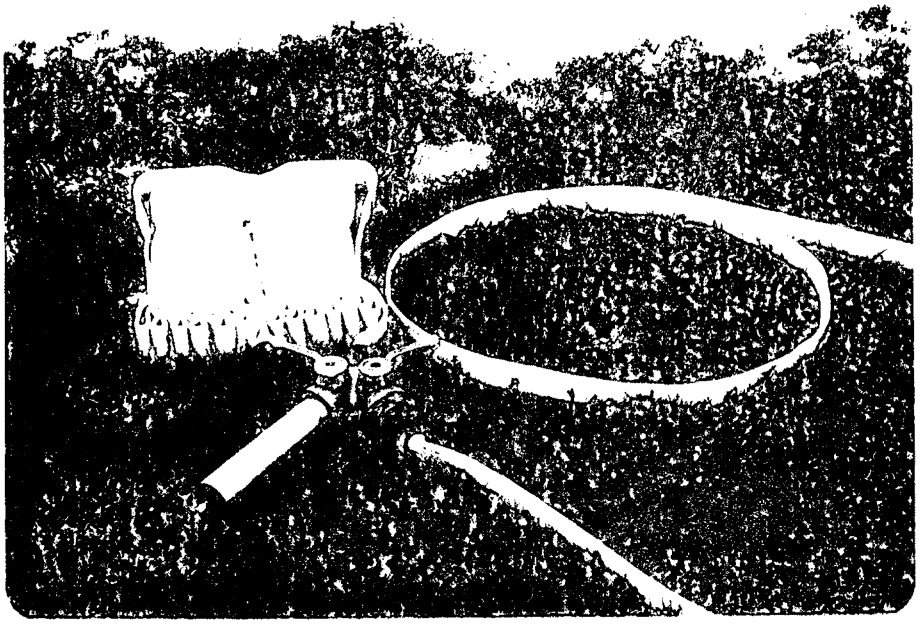


c. Nylon cord tying procedures for 1½" main line pack:



After strings have been tied remove pack from packing frame. (Use quick-knots for tie-downs)

d. Connect 1" hose lateral to gated wye with aid of reducer, connect Mark III primer to opposite side of wye, attach nozzle. Open both sides of wye and close nozzle, then deflate lateral hose. Form a circle, with nozzle inside, approximately 2½ feet in diameter, then spin-roll hose in a counterclockwise direction, as shown in photo below:

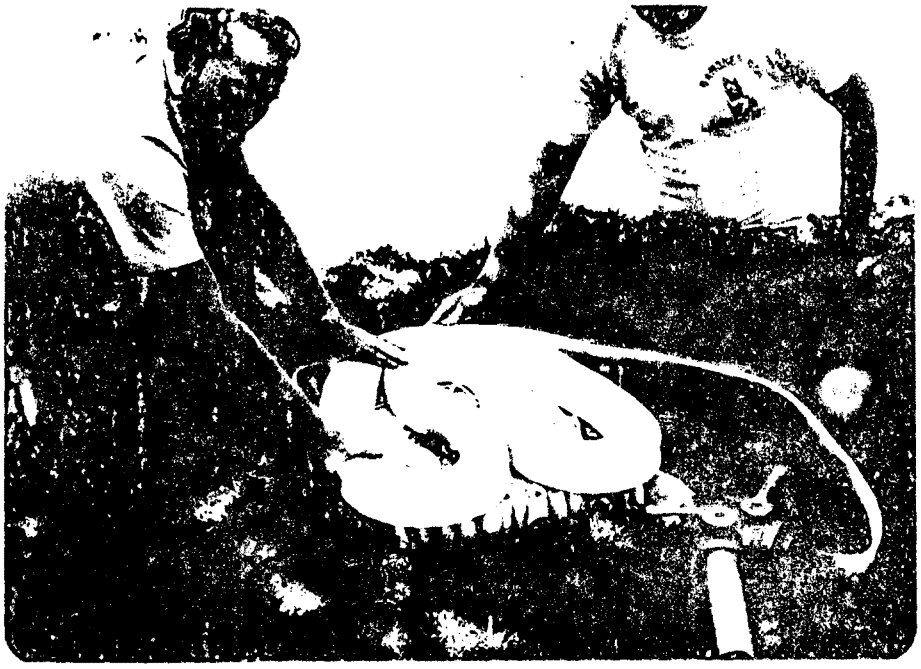


e. With counterclockwise spinning action finished and hose snug against wye and pack, the finished product should look as shown in photo below:

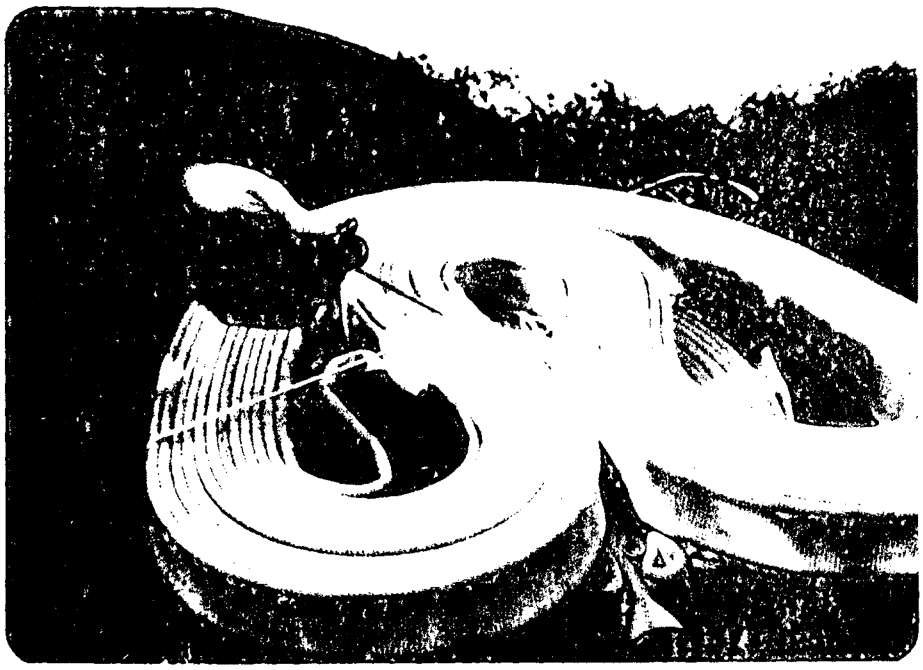
f. Pull rolled 1" lateral from gated wye coupling to middle of opposite side as shown in photo below:

g. Push ends of lateral together as shown in photo below:

h. Place lateral on top of finished 1½" pack as shown in photo below:



i. Tie nylon cord from far side to center of circle nearest gated wye as shown in photo below:



j. Tie opposite side as done in step I., but be certain wye is tied off to pack with this string, as shown in photo below:

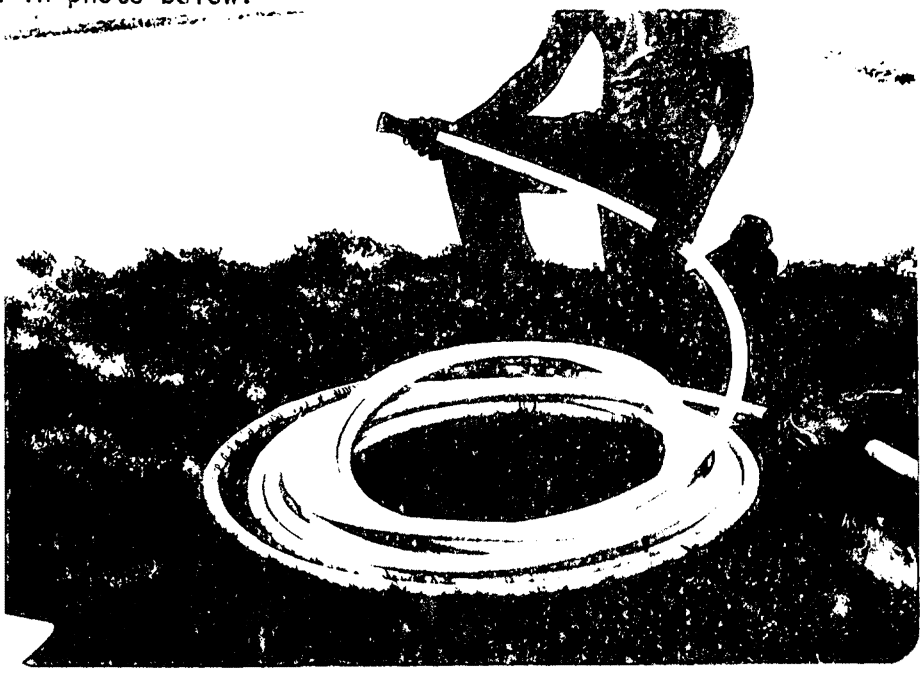
k. Divide leftover hose at top of pack creating two equal arm straps. Tie off with string as shown in photo below:

l. Tie 1½" pack and 1" pack together and remove Mark III primer. This will give you a finished product, as shown on back of firefighter. Notice that the 1" hose is against back of firefighter.

3. Hose Lay Procedures

a. Place hose on firefighter's back with 1" lateral against back, tie off female end of 1½" to water supply; engine or to preceding wye in progressive lay. As firefighter walks, 1½" hose will feed out as shown in photo below:

b. After 1½" is completely extended, lay 1" lateral on ground with gated wye facing up, proceed by untying quick-knots and opening lateral to full circle and charge 1" hose holding onto nozzle as shown in photo below:



c. Charged 1" lateral feeds out as you progress and proceed to next Gansner Pack progressive from gated wye.

The California Division of Forestry is using a doughnut roll in many Districts. The twin-axis feature of this harness serves as a horizontal pin. The pin is outside the center hose loop so the hose falls away when the center of the roll is reached. The male coupling section is exposed, and the entire roll is held intact by one or more tire tube bands. Two to four rolls are carried, depending on the terrain.

HOSE PACKSACKS. The Northern Intermountain, and Pacific Northwest Regions use a commercial hose packsack for laying hose on a fireline. Usually made of substantial canvas or heavy duck. Weight varies from 2 to 4 pounds. The hose packsack can be used alone or attached to a companion packboard. These packsacks are dimensioned to hold 300' to 400' of coupled linen hose which pays out through a side opening at the top. This method of handling hose in tankers, pickups, and aircraft offers some protection in transit.

It leaves the crewman's hands free during a hose lay operation.

HOSE CARRIER. Several commercial hose carriers have been designed for manpacking rolled hose. Varying amounts of single- or double-rolled hose can be placed on an aluminum base. These 1-", 1-1/2", and 2-1/2" rolls are held in place by horizontal and vertical web straps which are adjustable. A conventional shoulder harness, which frees the arms and hands, is used for backpacking. Such a carrier weighs under three pounds.

A somewhat similar expendable carrier using an eight-sided board for a base is available.

2.7.2 - TANKER TRAYS. The tanker crew at Idyllwild R.S. (San Jacinto District, San Bernardino N.F., R-5) uses an ingeneous method of hose storage on a large crew tanker. The initial lay is accordioned into an 8" x 33-5/8" x 38-1/2" (outside measurements) hose tray which slides into the rear hose compartment. When the tanker comes in with dirty used hose from the fireline, a loaded swing tray is installed in several minutes. Servicing time is dramatically reduced.

PORTABLE, MOUNTABLE, FLOATABLE, TRANSFER AND PTO PUMPERS

3.0 - PUMPS. The water requirements to knock down a troublesome fire are different from those for mopup. For example, flow and pressure requirements will vary, depending on whether a straight-stream, spray, or fog pattern is used.

SPECIAL CONSIDERATIONS INCLUDE:

- THE SIZE OF THE JOB -
  the length of perimeter to be worked with water, the volume of fuels involved, the size and arrangement of fuels, and the distance from the fire to water or tanker

- THE CHARACTER OF THE FIRE -
  either smoldering, creeping, running, crowning, and/or spotting

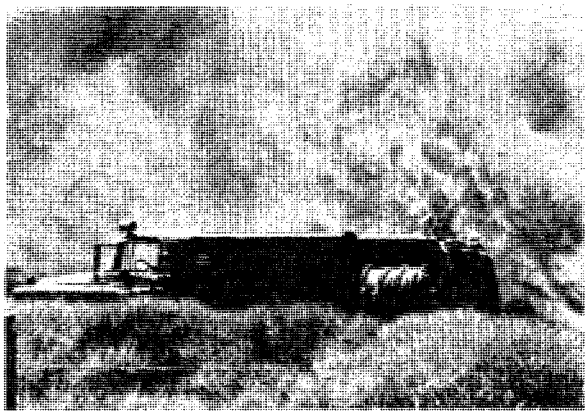
- THE NUMBER AND KIND OF EXPOSURES AHEAD OF THE FIRE -
  involving standing snags, down rotten logs, red slash, buildings, or a good stand of timber

- THE STATIC HEAD, FRICTION LOSS, AND NOZZLE PRESSURE NEEDED -
  all affecting engine pressure requirements

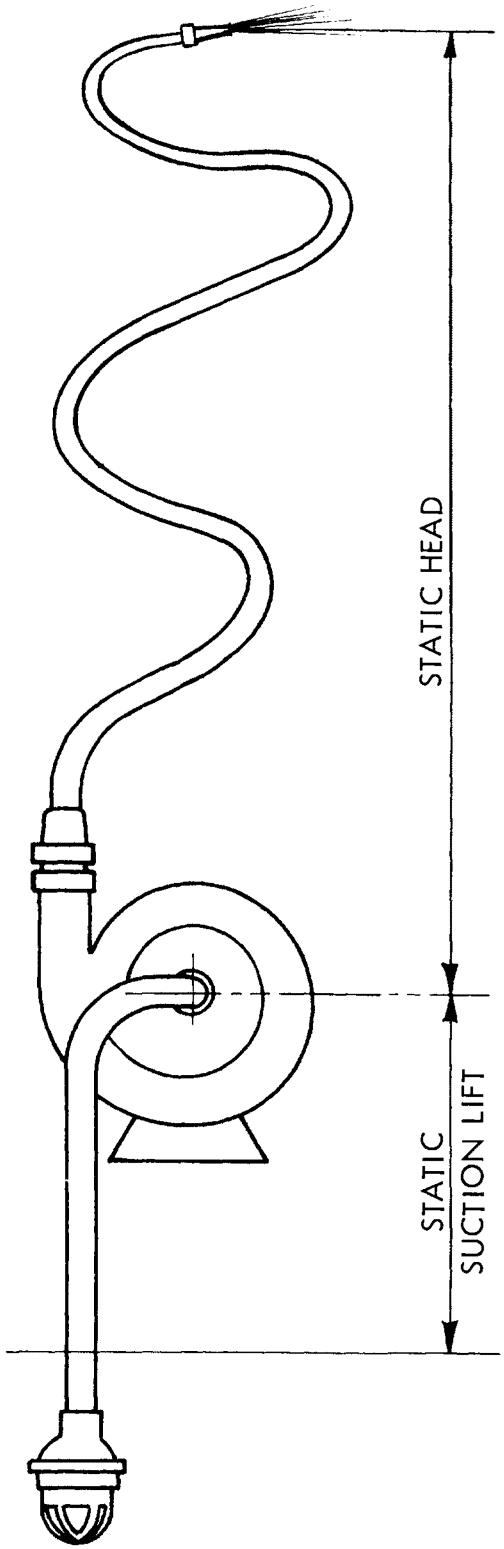
- AND MANY OTHER FACTORS -
  which establish flow (gpm) and pressure (psi) requirements for doing the job right and with a safe margin of assurance.

KNOCKDOWN PERFORMANCE.

The purpose of the Service-wide portable pumper updating program is to enable firefighters to select the pumper best suited for local conditions. Water can provide the firefighter with another efficient tool. Careful selection of the standardized tanker models, of qualified pumpers, and of selected water accessories will give the fireman both a line-holding and a hard-hitting knockdown capability.



In general, forestry agencies have been satisfied too long with outdated low-performance units with a capability for mopup work only.

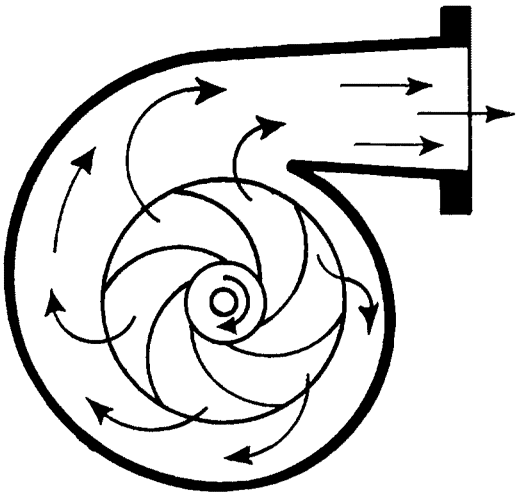


WORK ASSIGNMENTS. The typical fireline assignments for a forestry pump are demanding and require rugged equipment:

1. High flows (gpm) are often required, but the need is highly variable. Water conservation is also consistently important.
2. Service is through lightweight, small-diameter hose lines, where friction loss is comparatively high.
3. Hose lays are often long.
4. Hoses are often laid up steep slopes, with resulting high static head losses from pump to nozzle.
5. Water is customarily replaced under high static suction lifts from source to pump.
6. Engine power will be reduced as altitude increases.
7. Temperatures are often high.
8. Hours of work are long.
9. Long service life is required.
10. Weight is an extremely important factor, particularly with portable pumpers.
11. Available water is often abrasive.

TYPES OF PUMPS. The importance of flow, friction loss, head, lift, elevation, weight, and cost have all been shown. These considerations, so important to the forester, strongly influence the type of pump which should be selected for the protection area. Generally there are three classes of pumps in use - centrifugal, rotary, and reciprocating. For the purposes of this GUIDE, rotary and reciprocating pumps will be referred to as positive displacement pumps.

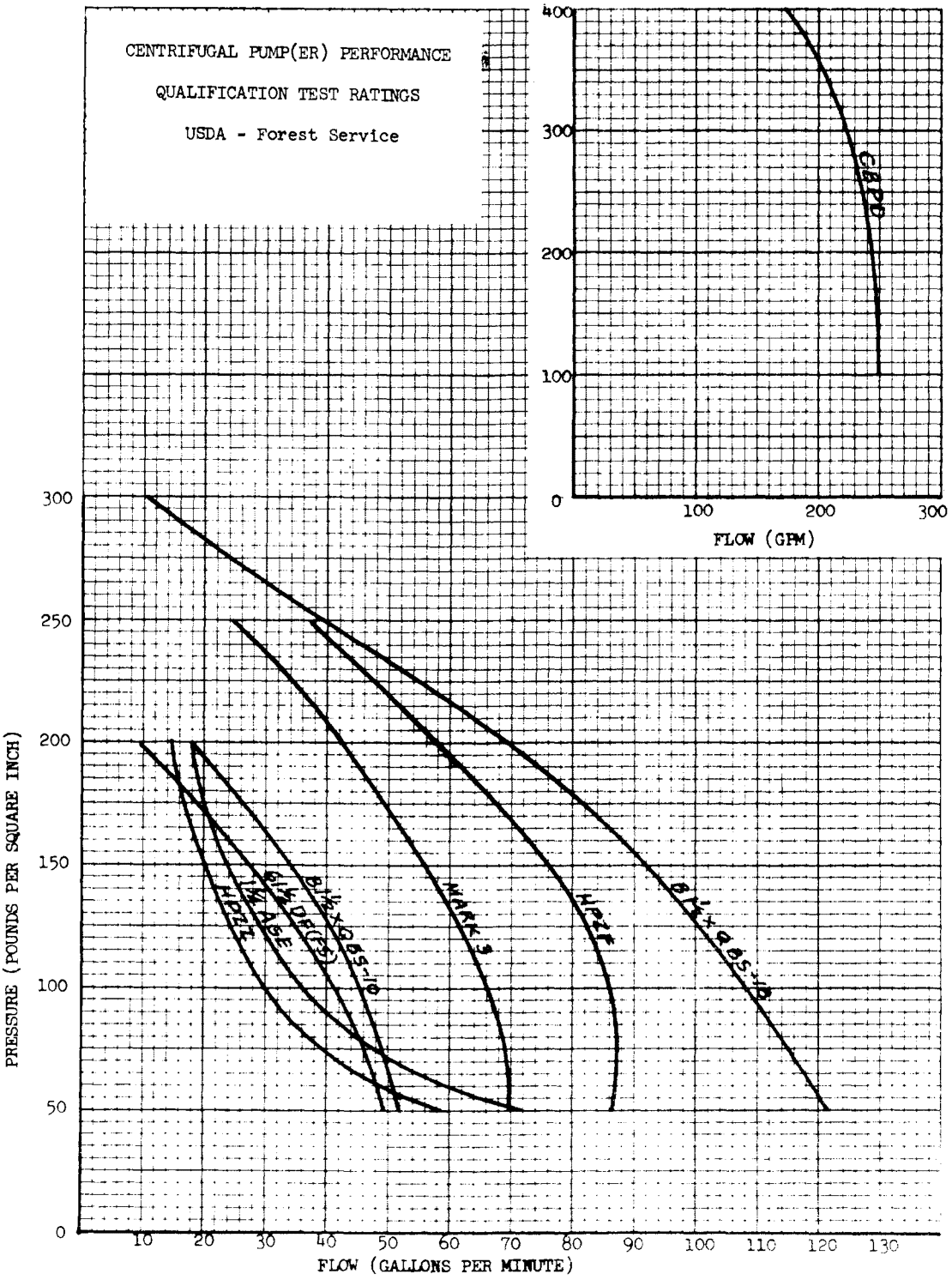
CENTRIFUGAL PUMPS. A centrifugal pump employs outward force from a center of rotation, known as the eye, to move or impel water. With these pumps the volume will vary with speed (rpm) and pressure. The single-stage pump, as used by the Forest Service, has one single impeller. Centrifugal pumps are usually larger than positive displacement units in design and are employed for higher volumes. These pumps require more horsepower, gallon for gallon, and are therefore usually not as efficient as positive displacement pumps.



The single-stage centrifugal pump volume and pressure are controlled by the engine's throttle. "Each centrifugal pump will have a point of maximum volume which is determined by the pump design, power available, and suction supply conditions. There is a cutoff for fire service centrifugal pumps which is approximately 450 psi . . ." (NFPA-Fire Chief's Hdbk., 1967). Generally, the pumps do not require pressure relief valves; but most makes require priming.

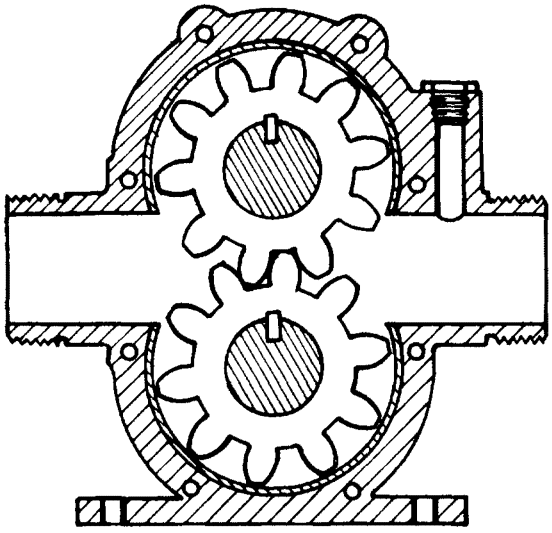
The Cedco (Hale) CBPD pump on the Model 60 Tanker and the Gorman-Rupp 02F1-GR on the Model 40 are examples of single-stage centrifugal pumps in FS use.

Following is a series of curves of centrifugal pump(er) performances taken from official tests conducted by the Forest Service.


CENTRIFUGAL PUMP(ER) PERFORMANCE
QUALIFICATION TEST RATINGS
USDA - Forest Service
400
300
200
100
0
100
200
300
FLOW (GPM)
C&LPD
300
250
200
150
100
50
0
PRESSURE (POUNDS PER SQUARE INCH)
10
20
30
40
50
60
70
80
90
100
110
120
130
FLOW (GALLONS PER MINUTE)
8½x8 65-10
6½ DF(FS)
1½ ABE
HPZZ
MARK 3
HPZZ
8½x8 65-10

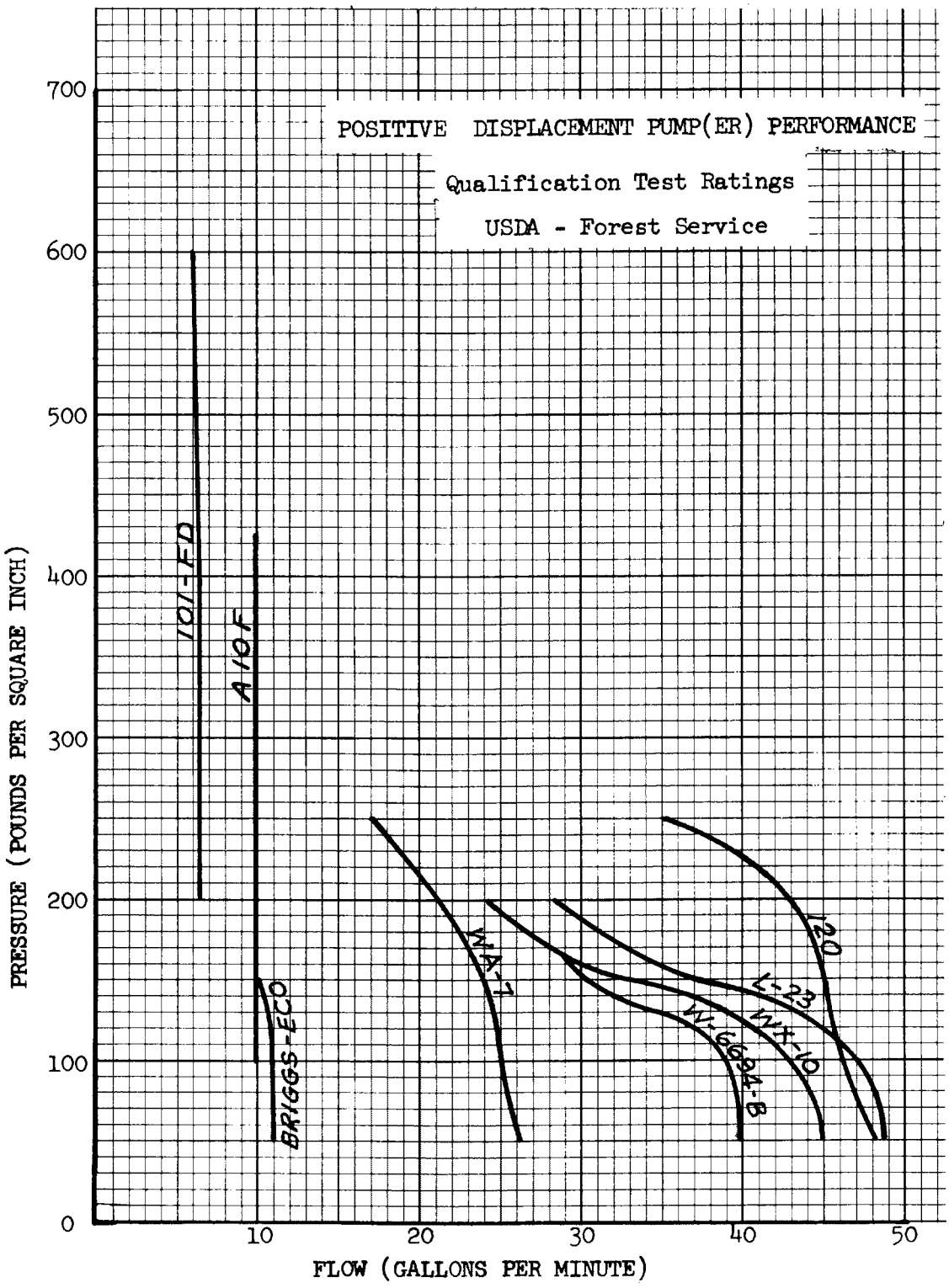
POSITIVE DISPLACEMENT PUMPS.

These pumps move a definite quantity of water with each stroke or revolution of the impeller. Volume depends only upon speed (rpm). The rotary gear, vane, cam-and-piston, and rotary-piston are typical units. Most are self-priming. Most require relief valves to handle line surges, overloads, and flows not needed at the nozzle. The illustration of a typical gear pump shows tight tolerances between the rotating parts and the pump housing. Most of these pumps are subject to serious abrasive damage. An exception is the Cedco A10F reciprocating-piston Wanner pump.



Generally, positive displacement pumpers are preferred for constant-flow, high-pressure applications. Examples are Pacific Pumper WX-10, Edwards L-23, and Eco-Western Fire 14X120A.

Following is a series of curves of POSITIVE DISPLACEMENT PUMP(ER) PERFORMANCES taken from official tests conducted by the Forest Service:


POSITIVE DISPLACEMENT PUMP(ER) PERFORMANCE
Qualification Test Ratings
USDA - Forest Service
PRESSURE (POUNDS PER SQUARE INCH)
FLOW (GALLONS PER MINUTE)
0
100
200
300
400
500
600
700
10
20
30
40
50
101-FD
A10F
BRIGGS-6223
WA-7
W.6694-B
W-X-10
V-23
120

SUMMARY OF CENTRIFUGAL AND POSITIVE DISPLACEMENT PUMPS.

Centrifugal Pumps

Advantages

- Pressure can be changed by adjusting rpm.
- Volume can be changed by adjusting psi and rpm.
- Relief valves not required.
- Dirty water and small particles can be passed without damage
- Refill performance good.

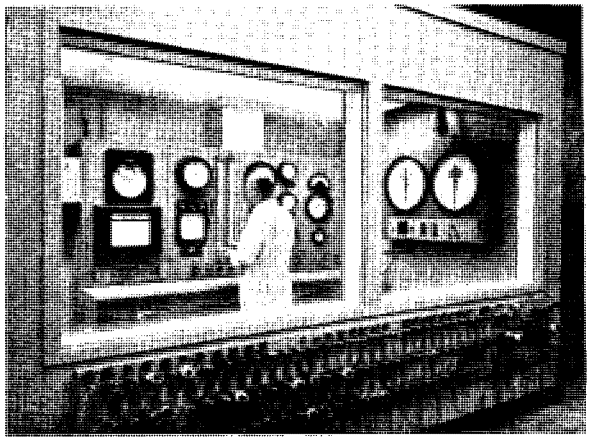
Disadvantages

- More power required for higher pressures.
- Primer usually required.
- To avoid heating bypass is required when no water is moved.

Positive Displacement Pumps

- Higher pressures can usually be produced with less power.
- Primers usually are not required.
- Damaged by dirty water.
- Relief valve required.
- Fixed output and psi performance not easily changed.
- Refill performance is low.

QUALIFICATION TESTS. These tests are conducted by the USDA Forest Service, Equipment Development Center, 444 E. Bonita Avenue, San Dimas, California 91773, to insure that pumpers offered by manufacturers will stand up under rugged field service. Laboratory apparatus, instrumentation, and sumps below pump level are available for measuring performances varying from 300 gpm @ 500 psi to 800 gpm @ 200 psi.



The pumpers submitted must pass an endurance test of 100 hours of intermittent service at a preselected rating and with 5 inches of vacuum at the pumper inlet. Those pumpers which pass the 100-hour test and meet all specification requirements are placed on a Qualified Products List (FSM 5162.41), the performance is coded, and the unit is described under sections 3.1, 3.2, 3.3, 3.4, and 3.6.

PERFORMANCE CODINGS. The performance of each qualified pumper is coded by the number of cycles (engine), type of pump, weight overall (dry), and performance (PSI/GPM).*

For example, a four-cycle centrifugal pumper tested under Specification 5100-273a and weighing not over 175 pounds (less starter) and operating between 15 and 19.9 gpm at 200 psi discharge pressure would be assigned a code of 4-C-175-20/15.

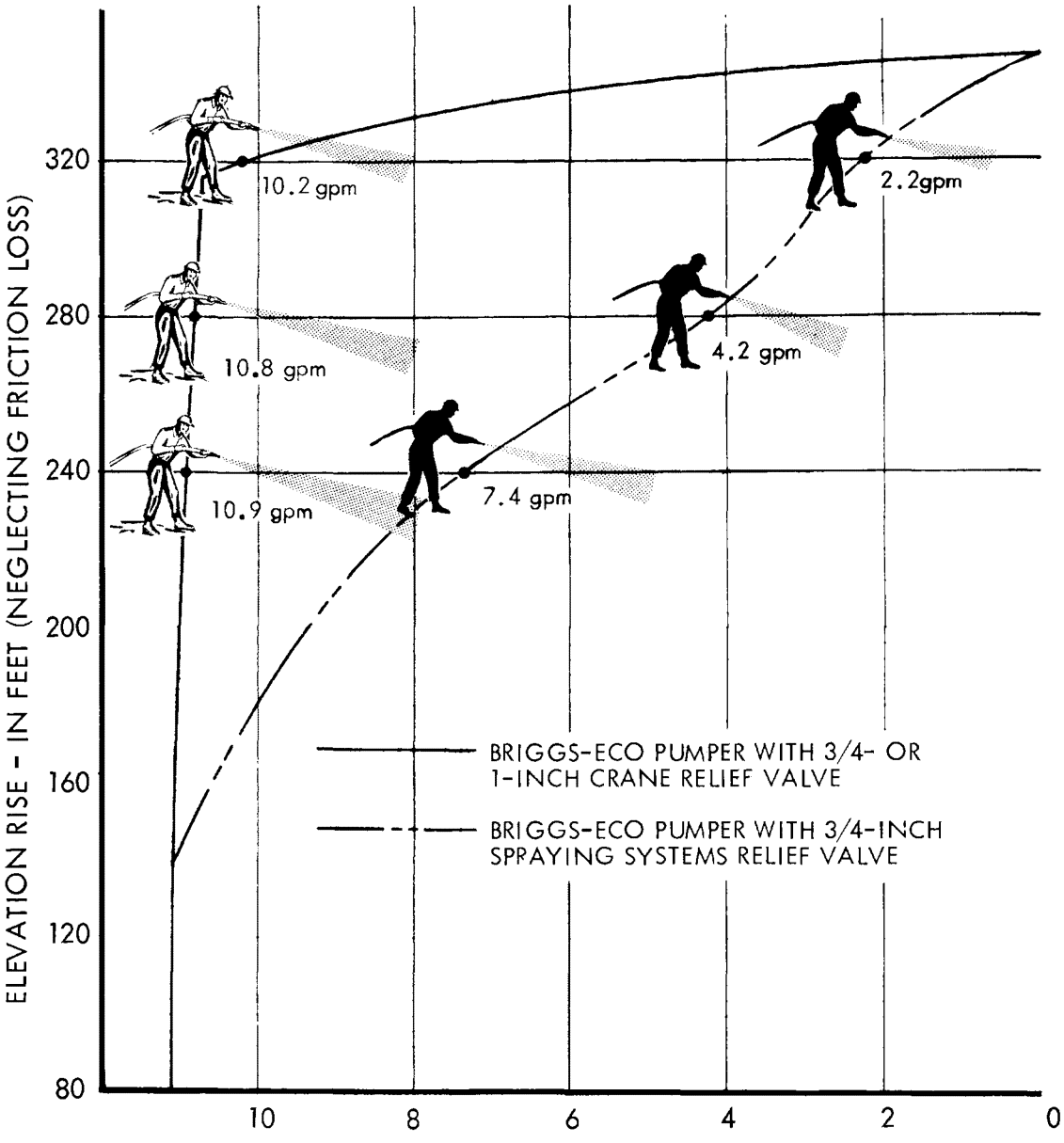
Under Specification 5100-274, the weight and performance classes are grouped differently; and all three digits of the psi range are included. For example, a positive displacement pumper with a two-cycle engine, weighing 27 pounds, and capable of 11 gpm at 175 psi would be assigned a code of 2-P-30-175/09.

RELIEF VALVES FOR MODEL 10, 20, AND 30 TANKERS WITH POSITIVE DISPLACEMENT PUMPERS. Detailed tests have been conducted at San Dimas to assist in the selection of relief valves for the new model tankers and for portable pumping assignments. The test measured:

- Factory setting of the cracking pressure
- Rate at which the relief valve discharged water when the pressure was increased
- Characteristics when the pressure was decreased

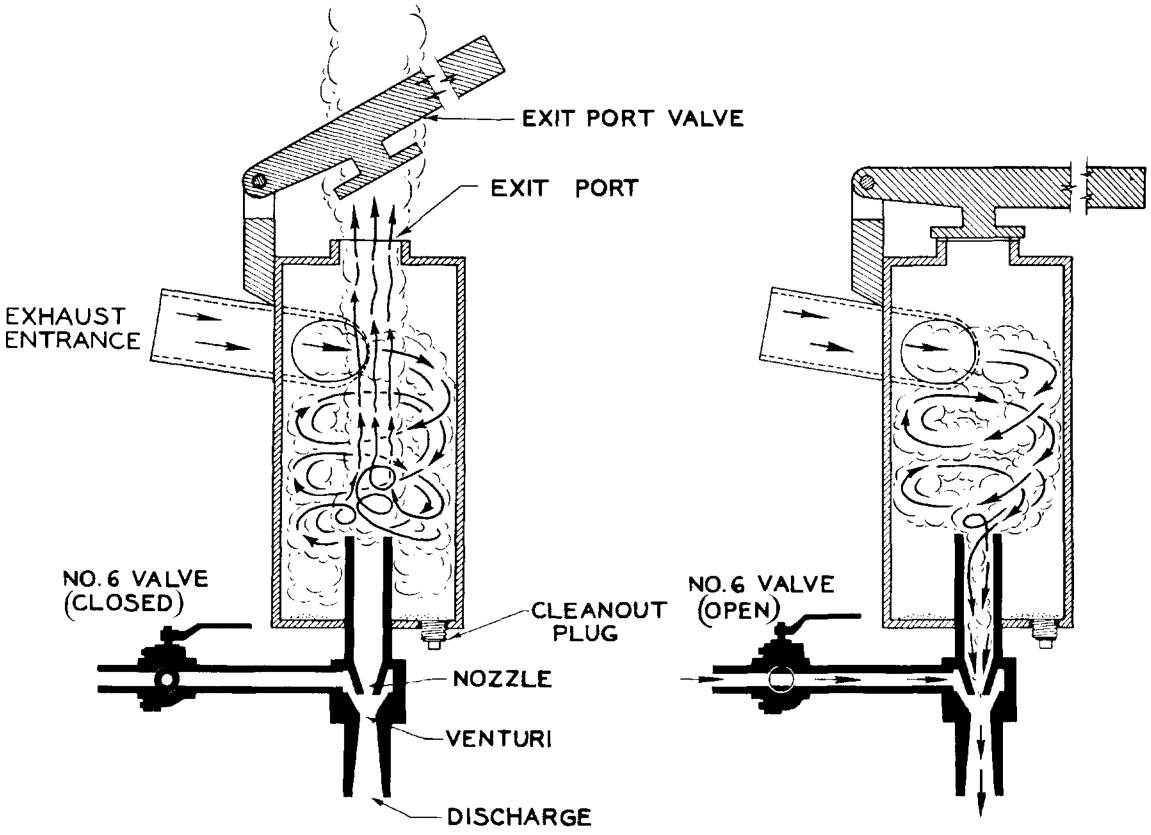
Valves have been selected which do not relieve any water until the established cracking pressure is reached. The following relief valve illustration of the curves shows how many valves will relieve some water at low pressures and thereby reduce the nozzle flow performance. On the other hand, the Crane valve losses were negligible until 312 feet was reached. At 280 feet, the Crane valve was delivering 10.8 gpm and the spraying systems valve, 4.2 gpm. Valves were eliminated which did not have acceptable performance patterns.

*Pumper performance (psi vs. gpm) is not called the same in the two FS Specifications, 5100-273a and 5100-274. If detail is needed a careful review of each specification is required.



BRIGGS-ECO PUMPER PERFORMANCE
RELATED TO ELEVATION RISE

EXHAUST PRIMER-ARRESTER FOR MODEL 20 AND 30 TANKERS WITH CENTRIFUGAL PUMPERS.



Most centrifugal pumpers used on Model 20 and 30 Tankers require priming. This is accomplished by using exhaust from the engine. The venturi action draws air from the pump, allowing water to fill the suction line and pump.

This primer has been modified so that the exhaust enters the primer body tangentially. This spinning action provides an efficient arrester when carefully designed and fabricated.

Cedco Primer-Arresters No. 1 and No. 2 have been qualified as acceptable spark arresters (FS-Spark Arrester Guide, 1966). Forest Service drawings are also available.

LIGHTWEIGHT PORTABLE PUMPERS

Weight: . . . . . 60 pounds or less
Performance: . . . . . coded; minimum - 9 gpm @ 150 psi
Carry: . . . . . one-man, backpack

3.1 - GENERAL DESCRIPTION. The one-man backpack pumpers qualified under Specification 5100-274 are used for direct attack on wildfires and for fireline mopup. These lightweight pumpers work well at advance relay pumping stations.

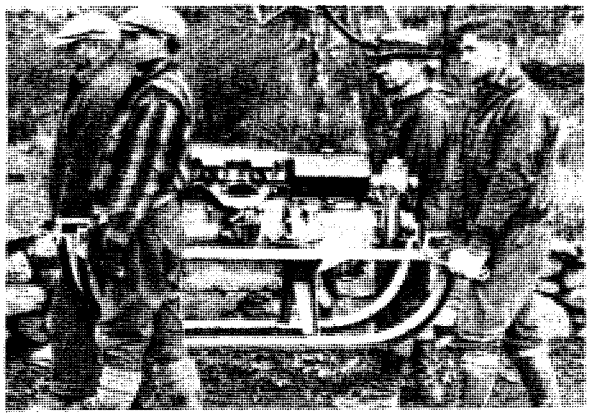
These high-performance pumpers are of rugged construction and are capable of operating at elevations up to 11,000 feet density altitude.

A remote fuel tank which features a quick-connect for a flexible fuel line connection is furnished by the manufacturer.

When specified by the contracting officer, a backpack frame and necessary harness shall be furnished with the pumper unit. The backpack frame may be the base framework of the pumper, or it may be entirely separate. Firemen may prefer to mount these pumpers on contoured tubular pack frames.

Photographs like the one on the right, taken several decades ago, remind us of the dramatic weight reductions made in the so-called portable pumper class.

The early four-man carry pumpers were reduced to two-man units, and more recently to one-man loads. In some instances these weight reductions have been made without reducing the overall hydraulic performance.



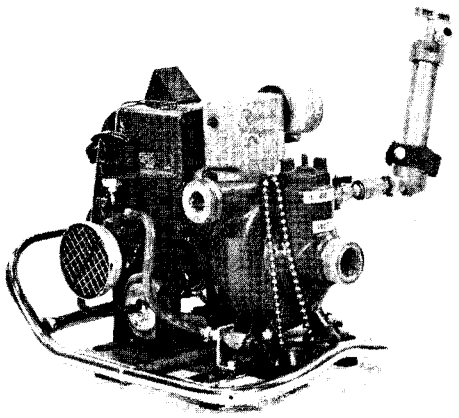
The accompanying photo includes several late developments in portable pumper equipment. The lightweight portable pumper was carried into this rough, mountainous area on a one-man pack. Several hundred feet of lined, cotton-synthetic hose made up a second load, in a hose packsack. The suction hose, remote fuel tank, and a few carefully selected accessories were incorporated onto a third packframe. Recent weight reductions and performance improvements have extended the potential use of portable pumper equipment.

3.1.1 - CENTRIFUGAL. There are several lightweight portable pumpers of the centrifugal type qualified under Specification 5100-274.

Two-Cycle, Centrifugal, 30 Pounds or Less
Coded: 2-C-30-150/25

GORMAN-RUPP MODEL 61-1/2 DF (FS)

Pumper performance, PSI/GPM: 50/50, 100/42, 150/27, and 175/20



GORMAN-RUPP Model 61-1/2 DF (FS) is a lightweight one-man backpack pumper. This is the lightest qualified portable pumper to date. It is compact, rugged, and simple to service and maintain.

The single-stage, centrifugal pump has a 1-1/2" N.S. Thread inlet and outlet. A detachable hand-priming pump is strapped to the frame.

Driven by a two-cycle, air-cooled West Bend - Chrysler engine (Model 82003) rated at 8 hp @ 7,000 rpm. The over-speed control automatically shuts the engine down at excessive speeds. The same control provides shutdown protection when prime is lost in unattended operation. Resets automatically for restarting. Equipped with a recoil rope starter. Uses gasoline-oil mixture with separate fuel can.

Dry weight: 29-1/2 pounds, excluding fuel can, priming pump, and canvas packboard. A lightweight frame doubles as a base.

Dimensions: 13-1/2" high x 11-1/2" wide x 18-1/2" long.

Mandatory modifications include an approved screen-type spark arrester.

Manufacturer: Gorman-Rupp, 305 Bowman Street, P.O. Box 1217, Mansfield, Ohio 44902.

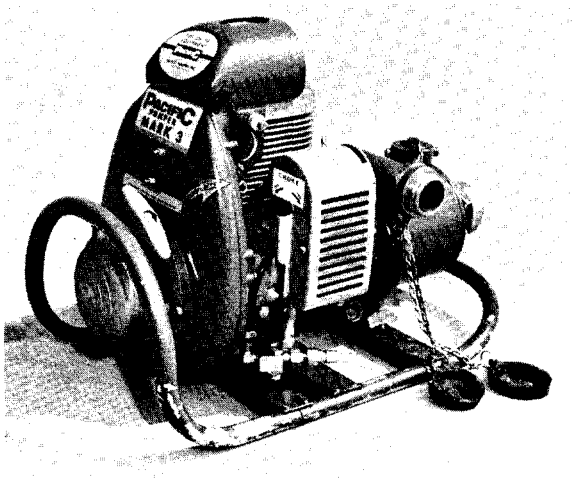
See GSA catalogs (Federal Supply Service): FSN 4320-08R-0237.

TERRY-HOMELITE Model T-7A was discontinued by the manufacturer and the Federal Supply Service in April 1969. Replacement parts should be available until 1972. This pumper should be high on your replacement list. See Section 3.1.2 for positive displacement pumpers which have been discontinued.

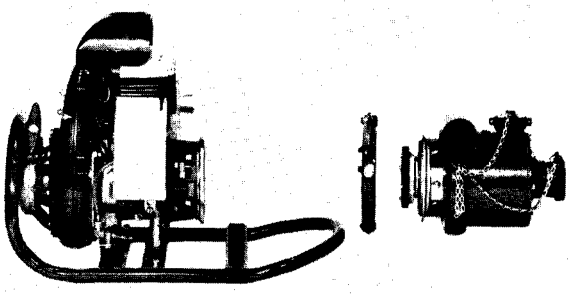
Two-Cycle, Centrifugal, 60 Pounds or Less
Coded: 2-C-60-200/35

PACIFIC PUMPER MODEL MARK 3

Pumper performance, PSI/GPM: 50/70, 100/67, 150/55, 200/44, and 250/25
(1-1/2" suction hose)



PACIFIC PUMPER Model Mark 3 is a lightweight, one-man backpack pumper. An efficient lightweight pumper with a high PSI to GPM performance and qualified under Specification 5100-274. Has a wide performance range and can handle muddy abrasive water if necessary.



The four-stage centrifugal assembly has a quick breakaway pump-to-powerhead feature for two-package transport or replacement. A hand-priming pump is furnished. The pump is manufactured with a 1-1/2" I.P. Thread outlet and a 2" I.P. Thread inlet. The suction side is standardized to 1-1/2" N.S. Thread dimension for most FS operations. At 200 psi and above, the performance will be similar for 1-1/2" and 2" suction hoses; but flows will be increased in the lower pressure ranges when the 2" inlet is used.

Driven by a two-cycle, air-cooled engine rated at 8.5 hp. Engine is equipped with an automatic cutout switch to prevent possible damage from overspeeding. Uses a rewind starter rope and a gasoline-oil fuel mixture.

Dry weight: 55 pounds, excluding fuel can, priming pump, and packboard. A lightweight frame doubles as a base.

Dimensions: 16-1/4" high x 12" wide x 22" long.

PACIFIC PUMPER MODEL MARK 3 (Continued)

Mandatory modifications: The specification requires (1) that the inlet be reduced and all threads converted to 1-1/2" N.S. Thread, (2) an approved spark arrester, and (3) standard quick-connect on the fuel line.

Manufacturer: Pacific Pumper, Inc., 1223 Western Avenue, Seattle, Washington 98101.

See GSA, Federal Supply Service: FSN 4320-08R-0005.

3.1.2 - POSITIVE DISPLACEMENT. There are no positive displacement pumpers qualified and in current production under Specification 5100-274.

PACIFIC PUMPER Models 5A5 and 5A7 were discontinued by the manufacturer at the end of the 1967 season. Parts for these pumpers are scarce, and replacement of these models should be the highest priority.

PACIFIC PUMPER Model Y was discontinued by the manufacturer in July 1969. Parts will be made available until July 1, 1975.

PORTABLE PUMPERS

Weight: . . . . . 61 pounds or more
Performance: . . . . . coded
Carry: . . . . . two- to four-man; with handles

3.2 - PORTABLE, 61 POUNDS OR MORE. The pumpers in this category are usually positive displacement units driven by four-cycle, air-cooled engines. These pumpers are equipped with handles for a two- and four-man carry. Weights vary from 130 to 200 pounds.

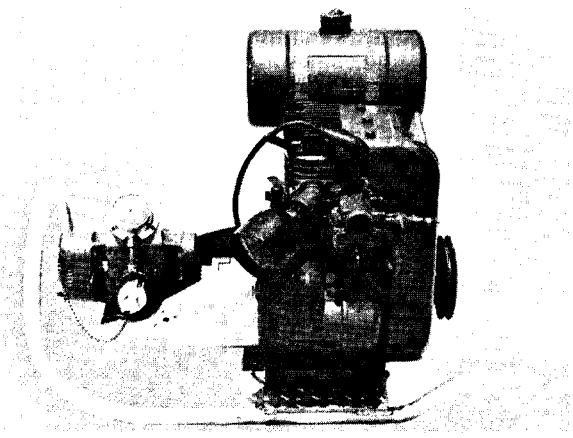
3.2.1 - CENTRIFUGAL PUMPERS. Currently there are no centrifugal pumpers qualified in this category under Specification 5100-273a, ENGINE-DRIVEN PUMPERS.

3.2.2 - POSITIVE DISPLACEMENT PUMPERS. Following are the positive displacement pumpers, by categories, qualified under Specification 5100-273a:

Four-Cycle, Positive Displacement, 130-Pound Class
Coded: P-130-25/15

PACIFIC PUMPER MODEL WA-7

Pumper performance, PSI/GPM: 50/26, 100/25, 150/24, 200/21, and 250/17



PACIFIC PUMPER Model WA-7 is a two-man-carry portable pumper and is plumbed into the Model 20 and 30 Slip-on Tankers. This rotary gear, positive displacement pump is equipped with 1-1/2" N.S. Thread inlet and outlet connections.

Driven by an air-cooled, four-cycle Wisconsin engine (Model BKND) rated at 6.8 hp @ 3,600 rpm. Available with rope or electric starter. Gasoline tank attached. Qualified with exhaust valve rotator and Stellite exhaust valve and seat. Uses regular gasoline.

Dry weight: 98 pounds; with starter, 130 pounds; base is removable.

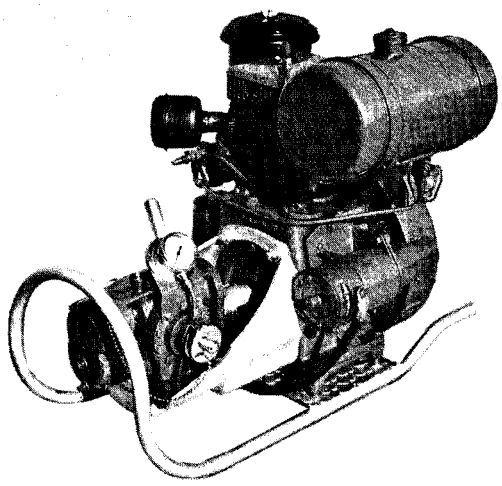
Dimensions: 20" high x 18" wide x 27" long.

Manufacturer: Pacific Pumper, Inc., 1223 Western Avenue, Seattle, Washington 98101.

Four-Cycle, Air-Cooled, Positive Displacement, 175-Pound Class
Coded: P-175-20/20

PACIFIC PUMPER WX-10

Pumper performance, PSI/GPM: 50/45, 100/43, 150/32, and 200/24



PACIFIC PUMPER Model WX-10 is a two-man-carry portable pumper and is also plumbed into the Model 20 and 30 Slip-on Tankers. This rotary gear, positive displacement pump has a 1-1/2" N.S. Thread inlet and outlet connection.

Driven by an air-cooled, four-cycle Wisconsin engine (Model AENLD) rated at 8.3 hp @ 3,400 rpm.

Available with rope or electric starter. Voltages available, 6 or 12 volt.

Uses regular gasoline. Gasoline tank attached.

Qualified with exhaust valve rotator and Stellite exhaust valve and seat.

Dry weight: 144 pounds; with starter, 170 pounds.

Dimensions: 23-1/2" high x 20-1/2" wide x 29-1/2" long.

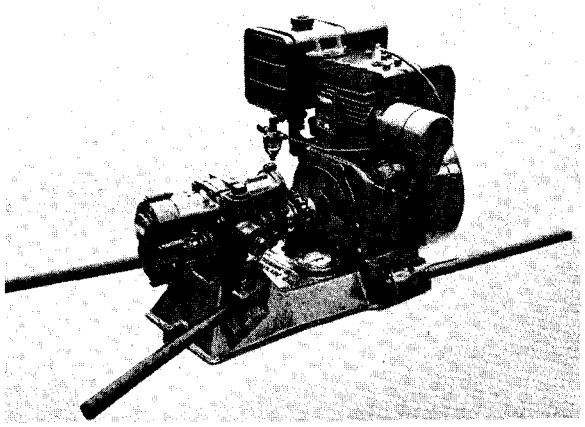
Manufacturer: Pacific Pumper, Inc., 1223 Western Avenue, Seattle, Washington 98101.

Four-Cycle, Positive Displacement, 175-Pound Class
Coded: P-175-20/25

EDWARDS MODEL L-23

Pumper performance, PSI/GPM: 50/49, 100/47, 150/37, and 200/28

EDWARDS Model L-23, used as a two- or four-man-carry portable pumper and with the Model 20 and 30 Slip-on Tankers. This rotary gear, positive displacement pump is furnished in 1-1/2" N.S. Thread connections, both inlet and outlet.



Driven by a four-cycle, air-cooled Briggs & Stratton engine (Model 23A-FB) rated at 9.0 hp @ 3,600 rpm. Available with rope or electric starter. Qualified with exhaust valve rotator and Stellite exhaust valve and seat. Gasoline tank attached; uses regular gasoline.

Dry weight: 154 pounds as shown; the base is an integral part of the assembly.

Dimensions: 21" high x 19-3/4" wide x 38" long.

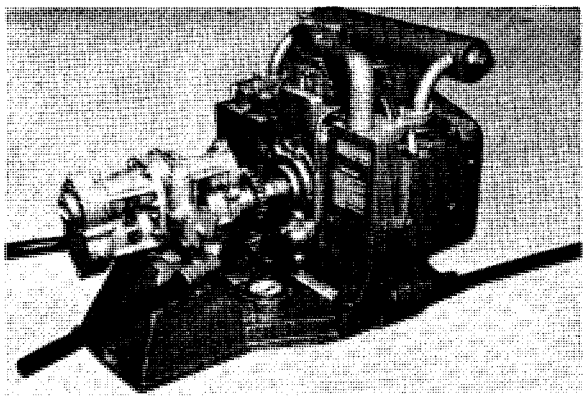
Manufacturer: Edwards Manufacturing Co., 8217 S.E. McLaughlin Blvd., Portland, Oregon 97222.

EDWARDS Models TS-25 and TSD-25 have not been qualified under a Forest Service Specification.

Four-Cycle, Positive Displacement, 200-Pound Class
Coded: P-200-25/35

EDWARDS 120

Pumper performance, PSI/GPM: 50/48, 100/46, 150/45, 200/43 and 250/35



EDWARDS 120 is a four-man-carry portable pumper. This rotary gear, positive displacement pump is heavier than but outperforms the lighter units. Furnished with 1-1/2" N.S. Thread connections, both inlet and outlet.

Driven by a four-cycle, air-cooled Onan engine (Model CK-10) rated at 10.1 hp @ 3,000 rpm. Available with rope, rewind, or electric starter. Qualified with exhaust valve rotator and Stellite exhaust valve and seat. Uses regular gasoline.

Dry weight: 183 pounds, as shown. The base is an integral part of the assembly.

Dimensions: 20-1/2" high x 20" wide x 30" long.

Manufacturer: Edwards Manufacturing Co., 8217 S.E. McLaughlin Blvd., Portland, Oregon 97222.

MOUNTABLE PUMPERS

3.3 - GENERAL. Both centrifugal and positive displacement pumpers have been qualified for slip-on tankers under Specification 5100-273a, ENGINE-DRIVEN PUMPERS. Weights vary widely from 40 to 400 pounds. Generally, these pumpers do not lend themselves to cross-country packing or aerial delivery.

3.3.1 - CENTRIFUGAL PUMPERS. Following are the centrifugal pumpers qualified in this category under Specification 5100-273a, ENGINE-DRIVEN PUMPERS:

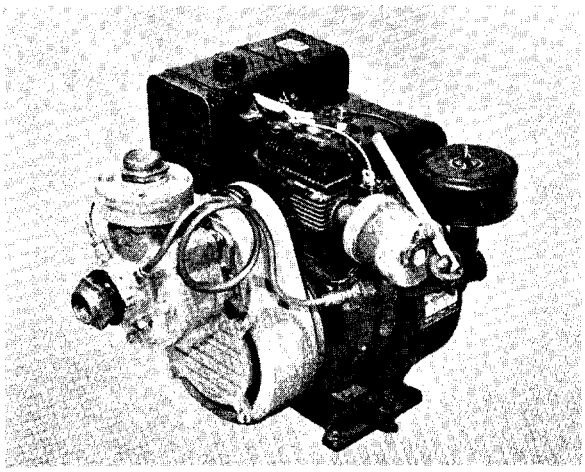
Four-Cycle, Centrifugal, 175-Pound Class
Coded: C-175-15/35 and C-175-20/15

BERKELEY MODEL B1-1/2XQBS-10

Pumper performance, PSI/GPM: 50/52, 100/44, 150/35, and 200/18

BERKELEY Model B1-1/2XQBS-10 is plumbed for use with the Model 20 and 30 Slip-on Tankers. This single-stage, centrifugal pumper has good performance characteristics. It is equipped with an exhaust priming device. Inlet and outlet connections are 1-1/2" N.S. Thread.

Driven by a four-cycle, air-cooled Briggs & Stratton (Model 243434) engine rated at 10.0 hp @ 3,600 rpm. Available with a starter. Uses regular gasoline.



Dry weight: 196 pounds with starter (170 pounds without).

Dimensions overall: 20" high x 23" wide x 24-1/2" long.

Mandatory modifications: (1) Protective spark plug boot provided and (2) primer ejector valve installed at pump end of ejector line.

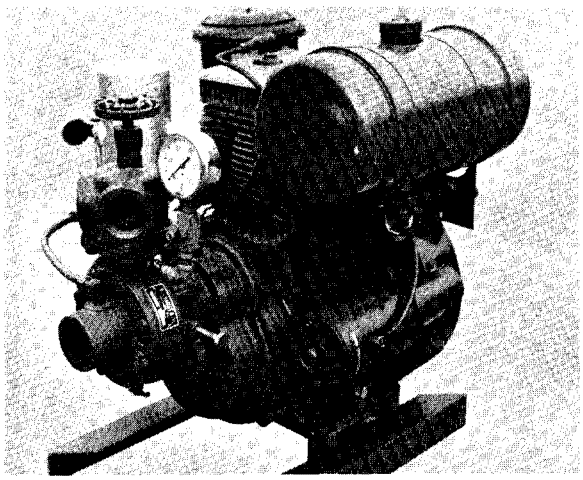
Manufacturer: Berkeley Pump Co., 829 Bancroft Way, Berkeley, California 94710.

Four-Cycle, Centrifugal, 175-Pound Class
Coded: C-175-20/15

DARLEY MODEL 1-1/4 AGE

Pumper performance, PSI/GPM: 50/72, 100/36, 150/24, and 200/18

DARLEY Model 1-1/4 AGE is plumbed for use with the Model 20 and 30 Slip-on Tankers. This single-stage, centrifugal pumper has good performance characteristics. It is equipped with an exhaust priming device. Inlet and outlet connections are 1-1/2" N.S. Thread.



Driven by a four-cycle, air-cooled AENLD Wisconsin engine rated at 8.3 hp @ 3,400 rpm. Available with rope or electric starter. Qualified with exhaust valve rotator and Stellite exhaust valve and seat. Uses regular gasoline.

Dry weight: 194 pounds with starter (168 pounds without). The base is removable.

Dimensions overall: 24" high x 21" wide x 24" long.

NOTE: The Darley Model 1-1/4 AGE 9B, with the 9 hp Briggs & Stratton engine, has not been qualified.

Manufacturer: W.S.Darley and Co., 2000 Anson Drive, Melrose Park, Illinois 60160.

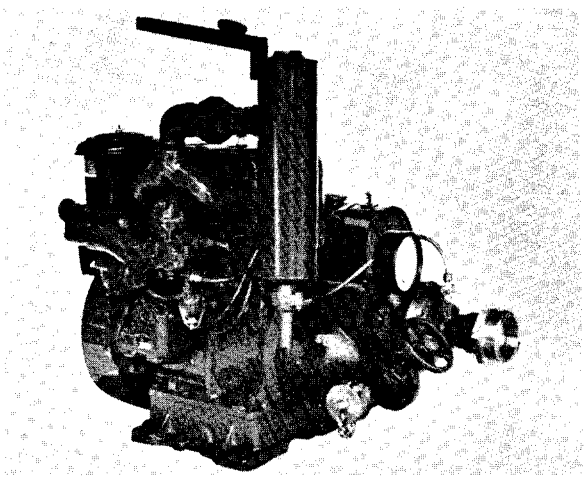
HALE Model HPZZ. See CEDCO Model HPZZ for a description.

Manufacturer: Hale Fire Pump Co., Conshohocken, Pennsylvania 19428.

Four-Cycle, Centrifugal, 400-Pound Class
Coded: C-400-20/50

CEDCO MODEL HPZF

Pumper performance, PSI/GPM: 50/87, 100/87, 150/77, 200/58, and 250/37



CEDCO Model HPZF is plumbed for the Model 50 Slip-on Tanker. This single-stage, centrifugal pump built by Hale and modified as a Cedco unit has a good maintenance record in R-5. This pumper is equipped with a qualified primer-arrester device (Cedco primer-arrester No. 2). The inlet and outlet connections are 1-1/2" N.S. Thread.

Driven by a four-cycle, two-cylinder, air-cooled, THD Wisconsin engine rated @ 18 hp @ 3,200 rpm. Hand-crank or electric starter option. Uses regular gasoline.

Dry weight: 303 pounds without starter.

Dimensions overall: 31-3/4" high x 30" wide x 28" long.

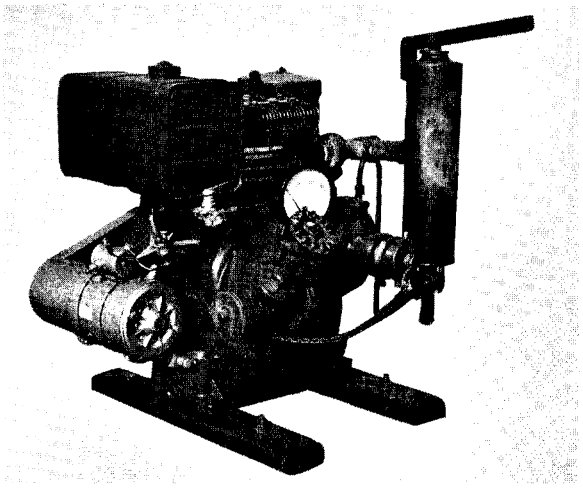
Mandatory modifications: (1) exhaust valve rotator, (2) Stellite exhaust valve and seat, and (3) U.S. double-spring gauge.

Manufacturer: Charles E. Duggan Company, 293 E. Santa Fe Drive, Pomona, California 91767.

Four-Cycle, Centrifugal, 175-Pound Class
Coded: C-175-20/15

CEDCO (OR HALE) MODEL HPZZ

Pumper performance, PSI/GPM: 50/60, 100/30, 150/20, and 200/15



CEDCO (OR HALE) Model HPZZ is plumbed for use with the Model 20 and 30 Slip-on Tankers. This single-stage, centrifugal pumper has a good maintenance record in R-5. This pumper is equipped with a qualified primer-arrester device (Cedco Primer-Arrester No. 1). Inlet and outlet connections are 1-1/2" N.S. Thread.

Driven by a four-cycle, air-cooled Briggs & Stratton engine (Model 233431-0180) rated at 9.0 hp @ 3,600 rpm. Available with rope or electric starter; qualified with exhaust valve rotator and Stellite exhaust valve and seat. Uses regular gasoline.

Dry weight: 171 pounds dry weight, as shown. The base is removable.

Dimensions: 24" high x 21" wide x 24-1/4" long.

Manufacturer: Charles E. Duggan Co., 293 E. Santa Fe Drive, Pomona, California 91767.

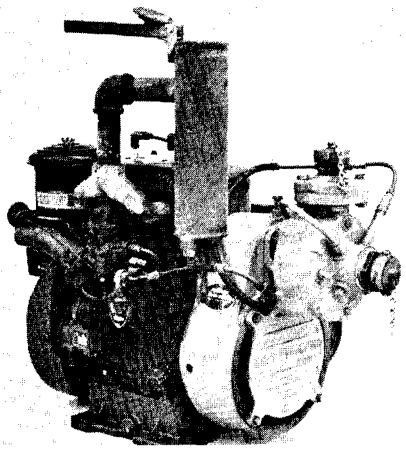
Four-Cycle, Centrifugal, 400-Pound Class
Coded: C-400-20/70

BERKELEY MODEL B1-1/2XQBS-18

Pumper performance, PSI/GPM: 50/122, 100/114, 150/96, 200/70, 250/39, 275/21, and 300/10

BERKELEY Model B1-1/2XQBS-18 can be used with the Model 50 Slip-on Tanker. This single-stage, centrifugal pumper is equipped with an exhaust ejector priming device. The inlet connections are 2-1/2" N.S. Thread; the outlet is 1-1/2" N.S. Thread.

Driven by a four-cycle, air-cooled, THD Wisconsin engine rated at 18 hp @ 3,200 rpm. Crank or electric starter available. Uses regular gasoline.



Dry weight: 356 pounds with starter (330 pounds without). The base is an integral part of the assembly.

Dimensions overall: 31" high x 25" wide x 33" long.

Mandatory modifications: (1) three-way cock to permit attachment of an auxiliary fuel supply; (2) an external control of the carburetor to adjust the fuel-to-air ratio for differences in density altitude; and (3) a Berkeley Model BM-6090 exhaust primer-spark arrester as per FS drawing F70-02.

Manufacturer: Berkeley Pump Company, 829 Bancroft Way, Berkeley, California 94710.

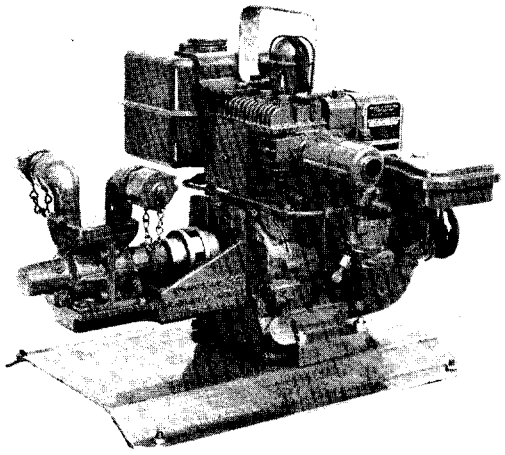
3.3.2 - POSITIVE DISPLACEMENT PUMPERS. Following are the positive displacement pumpers qualified in this category under Specification 5100-273a, ENGINE-DRIVEN PUMPERS:

Four-Cycle, Positive Displacement, 45-Pound Class
Coded: P-045-15/08

EDWARDS EBE, PACIFIC PUMPER BE, AND WESTERN FIRE 14X120A

Pumper performance, PSI/GPM: 50/11, 100/11, and 150/10

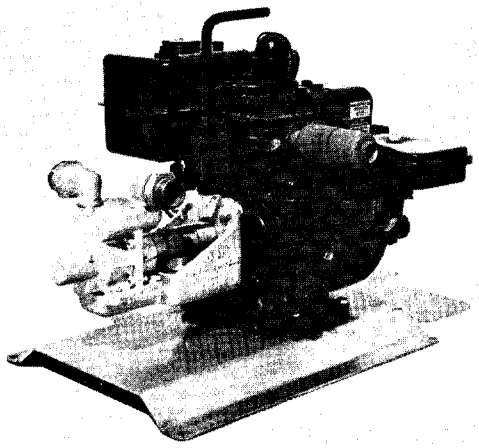
EDWARDS EBE



These Briggs engine-Eco pump assemblies are all similar. A general description follows:

The Briggs-Eco pumper is used in the Model 10 and 30 Slip-on Tankers. This Eco rotary pump, Model 251D, is a vane-type, positive displacement pump. The hose thread size is 1" on both the inlet and outlet. Slip-on tanker specifications require Compound 107 impellers for Forest Service use.

PACIFIC PUMPER BE



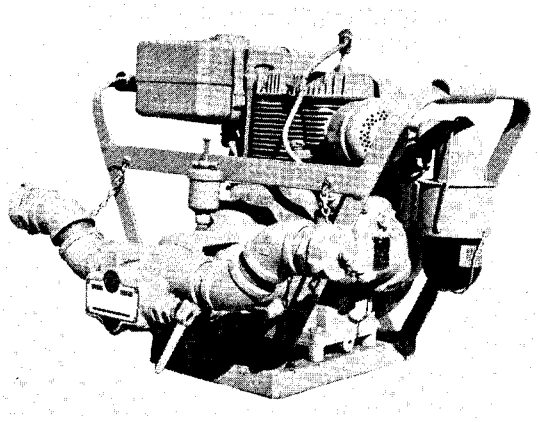
This small pump is driven by a four-cycle, air-cooled, Briggs & Stratton engine (Model 80332), rated at 3.0 hp @ 3,600 rpm. Rewind rope starter only; mounted in the 12 o'clock position to avoid hand injuries from the air-cleaner lip. When a spark arrester is required, a Gill 3C1P, or equal, is supplied. All pumpers qualified with (1) exhaust valve rotator and (2) Stellite exhaust valve and seat. Uses regular gasoline.

Four-Cycle, Positive Displacement, 130-Pound Class
Coded: P-130-15/30

MP DURAFLEX MODEL W-6694-B

Pumper performance, PSI/GPM: 50/40, 100/38, 150/31, and 165/28

MP DURAFLEX Model W-6694-B is proposed for Model 20 and 30 Slip-on Tankers. The self-priming positive displacement pump has a 1-1/2" N.S. Thread inlet and outlet. The relief valve built into the pump housing does not meet Forest Service requirements.



Driven by a four-cycle, air-cooled, BKND Wisconsin engine rated at 7.0 hp @ 3,600 rpm. Tests show the electric starter-generator is needed.

Dry weight: 144 pounds with starter (118-1/2 pounds without); handles and base are removable as one assembly.

Dimensions: 18-1/4" high x 23" wide x 22" long.

Mandatory modifications: (1) pump seal (Crane 1625 GF); (2) locknuts on packing adjustment studs.

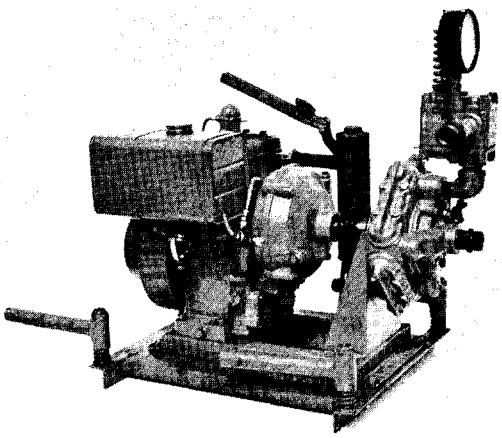
Manufacturer: M.P. Pumps, Inc., 515 Lycaste, Detroit, Michigan 48214.

Four-Cycle, Positive Displacement, 130-Pound Class
Coded: P-130-40/08

CEDCO MODEL A10F

Pumper performance, PSI/GPM: 100/10, 200/10, 300/10, and 425/10

CEDCO Model A10F is plumbed for use with the Model 20 and 30 Slip-on Tankers, where high pressures are needed. This four-piston, positive displacement Wanner pump is capable of handling muddy water and abrasive solutions if necessary. The pumper is equipped with a primer-arrester assembly. The inlet and outlet connections are 1" I.P. Thread.



Driven by a four-cycle, air-cooled Briggs & Stratton engine, Model 142451, rated at 6 hp @ 3,150 rpm. Available with an electric starter or with a rewind starter rope.

The unloader valve should be replaced with a standard relief valve as specified.

Dry weight: 124 pounds (without starter).

Dimensions overall: 25-1/4" high x 18" wide x 27-1/4" long.

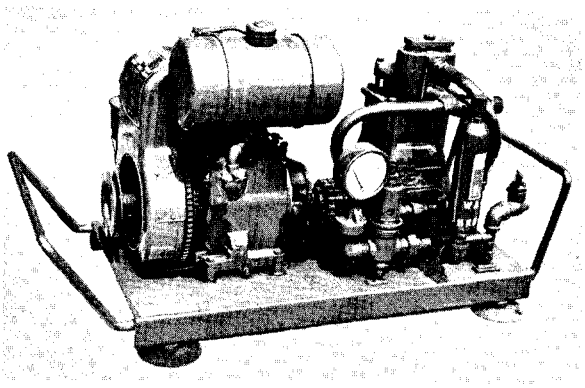
Mandatory modifications: (1) exhaust valve rotator, (2) Stellite exhaust valve and seat, and (3) engine-to-pump flex coupling, Rex D35-18. Uses regular gasoline.

Manufacturer: Charles E. Duggan Company, 293 E. Santa Fe Drive, Pomona, California 91767.

Four-Cycle, Air-Cooled, Positive Displacement, 300-Pound Class
Coded: P-300-60/06

JOHN BEAN MODEL 101-FD

Pumper performance, PSI/GPM: 200/6.5, 300/6.5, 400/6.4, 500/6.2 and 600/6.0



JOHN BEAN Model 101-FD is used where high pressures are required. The assembly produces a comparatively low-flow, high-pressure fog. This Royalette pump with Sapphite cylinders will handle some dirty water, if necessary. Abrasive spray materials can also be used without damage. Lubrication of all working parts is handled in a clean oil bath. External lubrication is not required, and oil is added at one place only. There are few moving parts. The positive displacement pump is equipped with a 1" inlet and a 3/4" outlet.

Driven by a four-cycle, air-cooled Model BKND Wisconsin engine rated at 6.1 hp @ 3,000 rpm. Available with rope or electric starter. Uses regular gasoline.

Dry weight: 209 pounds

Dimensions overall: 21-1/2" high x 21" wide x 39" long. The base is an integral part of the assembly.

Mandatory modifications include: (1) exhaust valve rotator and (2) Stellite exhaust valve and seat.

The manufacturer sells this high-pressure fog pumper in an outfit known as "101-FD Portable FMC Fire Fighter." Included with the pumper are a bypass valve, a pressure gauge, 150' of 1/2" ID high-pressure hose, a length of suction hose with strainer, and a Bean gun.

The "201-FD Demountable Fog Fire Fighter" includes a 100-gallon tank and a hose reel. The tank and reel are nonstandard equipment.

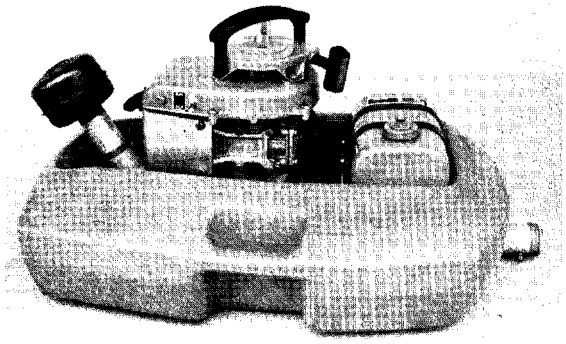
Manufacturer: FMC Corporation, John Bean Division, Box 145, San Jose, California 95103.

FLOATABLE PUMPERS

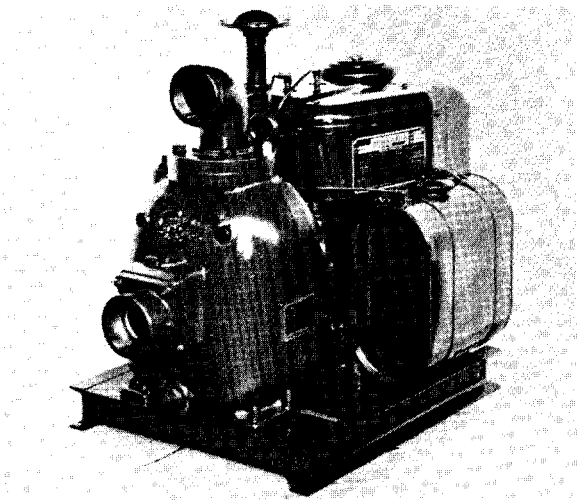
3.4 - GENERAL. Several high-volume pumpers that float on the water surface have been demonstrated. These are usually two-cycle, air-cooled engines with small gasoline tanks attached. They are customarily equipped with centrifugal pumps so they can handle dirty water. The screened intake opening is located in the bottom of the unit, entirely eliminating the use of suction hose.

SPECIFICATION. To date the Forest Service does not have a specification for floatable pumpers. Tentative requirements justify a lightweight, carryable unit producing at least 150 psi at the pumper and capable of maintaining an adequate flow at high altitude conditions.

TESTS. Preliminary tests were conducted on an early model with a comparatively high-volume, low-head range. The pump discharge flow rate increased rapidly with decreasing pressure at a near-linear rate to a flow of 143 gpm at 15 psi. The pumper cutoff pressure was 110 psi. One unit has been modified for Forest Service test purposes, and the development of a realistic forestry specification is pending.



TRANSFER PUMPERS



3.5 - GENERAL. Transfer pumps and pumpers are used to pump to and from water storage tanks and reservoirs. They may be used for direct loading of tankers and water haulers. These high-volume units handle dirty water, solutions, viscous water, and firefighting chemicals. (See Chapter VII of the NFPA Handbook, CHEMICALS FOR FOREST FIREFIGHTING.) From Equipment Development Center experience and limited tests, information is available for the following performance pump classes with water:

150- to 200-gpm pressure range, 60-psi shutoff
350- to 400-gpm pressure range, 60- to 90-psi shutoff
750-gpm pressure range, 121-psi shutoff.

WRITTEN MATERIALS: See the NFPA reference above or ask the Equipment Development Center, 444 East Bonita Avenue, San Dimas, California 91773, for data sheets by pumping range and job involved. A Forest Service specification is not available for transfer pumps or pumpers, and therefore no qualified products list is available.

POWER TAKE-OFF PUMPS

(For Tanker Models 56 and 60)

SPECIFICATION. Specification 5100-R5-07 describes a PTO pump capable of handling either water or viscous and abrasive fire retardants. The important requirements are briefly summarized:

1. Performance range, PSI/GPM: 100/275, 300/225, and 400/150. The above performance with water is based on a 5' lift through 16' of 2-1/2" suction hose. The pump shall also be capable of pumping fire retardant slurries with 30 percent solids at 100 gpm @ 250 psi.

2. Drive rotation - clockwise.

3. Weight, dry - 100 pounds or less.

4. Dimensions (maximum allowable), 15" high x 12" wide x 16" long.

5. Pump inlet and outlet dimensions and threads - inlet not less than 3"; outlet shall be 2"; threads shall be either American National Taper pipe or Dryseal American National Standard Taper pipe.

6. Pump shaft seal - must be able to be quickly replaced; tested for 100 hours of operation with water or 50 hours with a specified fire retardant without excessive leakage.

7. Pump input drive speeds - range 2,000 to 3,500 rpm.

QUALIFIED PRODUCT LIST. Hale (Cedco) centrifugal, type CBPD; suction, 3"; discharge, 2"; weight, 79 pounds. Test performance PSI/GPM: 100/275, 300/225, and 400/175.

WRITTEN MATERIALS. Specification 5100-R5-07 - Pumps, Power Take-off-Driven.

SPECIFICATION. Specification 5100-R5-04 for the 75-, 125-, and 200-Gallon PTO Tanker requires that the pump used deliver 70 gpm @ 200 psi at an engine speed of 2,600 rpm or below. The pump must be self-priming and must be capable of picking up a draft through three sections of 1-1/2" suction hose without exceeding 1,400 rpm.

ACCEPTABLE PRODUCT. Gorman-Rupp Model 02F1-GR - self-priming, single-stage, centrifugal pump. Rated at 132 gpm @ 200 psi @ 2,500 rpm engine speed.

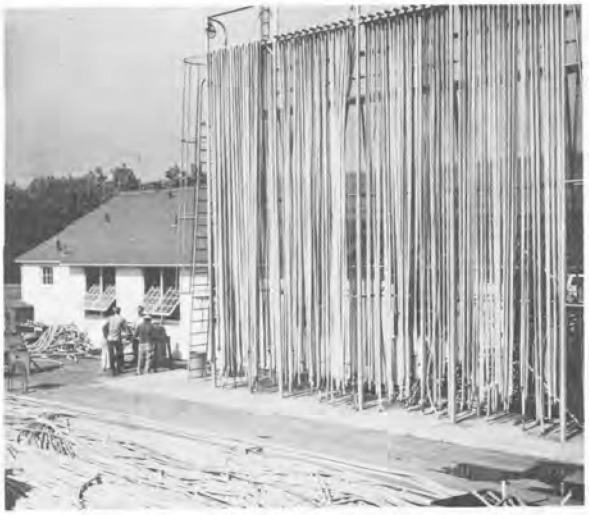
FIRE HOSE

4.0 - GENERAL. Fire hose provides the essential means of transporting water from a stream, lake, hydrant, or tanker to the fire. The hose selected must be able to withstand the necessary pressures involved, yet be flexible and lightweight enough to handle. Most hose in Forest Service use is purchased by Federal Supply Service (GSA) under specifications developed by the Forest Service.

The Forest Service purchases around 2,000,000 ft of small diameter (1" and 1½") fire hose annually. About two-thirds of the total is lined hose, the balance unlined linen.

The care and maintenance of fire hose is described in detail in NFPA Pocket Edition No. 198.

A review of the appropriate definitions (Section 1.2) and abbreviations (Section 1.3) will be helpful when using this section on Fire Hose.



The subject of fire hose streams should be studied considering both nozzles (Section 5) and fire hose.

The couplings and threads used on Forest Service hose lines are discussed in Section 6. The pump pressure tables are in the Appendix.

4.1 - TYPES. Most of the small diameter hoselays used in forestry practice are of the single woven-jacket, rubber-lined type. The remaining one-third of the hose used is unlined. A brief description follows of the more important types in use.

4.1.1 - SINGLE-COTTON-JACKET, RUBBER-LINED. Standard cotton-jackets are used where average working pressures (300 psi) are required. All-cotton is less liable to heat and flame damage than synthetic fibers. Hot embers, however, may cause small pinhole damage. Cotton-jacketed hose is normally supplied by GSA for Model 51 tanker and portable pumper use in 1- and 1½-in. diameters under Forest Service Specification 182.

4.1.2 - SINGLE-COTTON-SYNTHETIC JACKET, RUBBER-LINED.

Medium-weight cotton-synthetic jacket hose is used where higher working pressures (450 psi) are required, as on the Model 56 and 60 Tankers. The cotton fibers run lengthwise (warp), and the synthetic fillers run crosswise, to form the weave. This combination makes a lighter, stronger jacket, but is more subject to heat and flame damage. A Grade A liner is also available under Specification 5100-00186 which is capable of withstanding long periods of weather aging and high ozone conditions without checking or cracking although costs are higher than all-cotton. These additional requirements raise the cost to significantly more than all-cotton. Combination fabric jackets are available in both 1- and 1½-in. diameters, and are usually furnished in 100-ft lengths.

One-in. hose is used in the standard hose baskets that are provided with some Model 20 and 40 tankers.

4.1.3 - DOUBLE-JACKET, -LINED.

Double-jacketed hose is heavier and more costly than single-jacketed hose. In Forest Service practice, Model 60 Tankers carry one or two lengths of double-jacketed hose for the first lengths in the lay, thus reducing excessive losses from bursts close to the tanker.

A limited amount of 2½-in. is also used at airtanker bases for loading fire retardants. Since use of 1½- and 2½-in. diameter is limited, needs are normally filled by open marked purchases.

4.1.4 - UNLINED (LINEN). Unlined hose was originally designed for indoor standpipe use. Because of its lightweight, flexibility when dry, and relatively inexpensive construction, unlined hose is used where water is readily available. Unlined linen is stiff when wet, is subject to abrasion, seeps through the jacket and must be thoroughly washed and dried after use. Linen also requires protection from mildew. Because of seepage and friction of the tube, the hydraulic efficiency is inherently lower than lined hose so friction loss factors are higher. However, the water seepage through the jacket at working pressures offers good protection to the jacket from exposure to fire embers or coals.

Linen is also used with portable pumpers and in gravity systems for control and mop-up. It is not suitable for use on tankers or practical for drills.

Both 1- and $1\frac{1}{2}$-in. linen is available from GSA in 100-ft lengths under Forest Service Specification 5100-183.

4.1.5 - UNLINED (SYNTHETIC). Evaluations have been conducted on $1\frac{1}{2}$-in. fire hose that has an unlined, synthetic jacket in place of linen (flax). The results were:

ADVANTAGES

1. Washing and drying were simplified.

2. Handling was easier because of increased flexibility, reduced weight, and somewhat smaller roll size.

3. Flexibility in both dry and wet hose was significantly better than linen. The brand tested was "limp when wet".

4. Washing pressure, proof pressure, and burst pressure, were raised somewhat over linen.

5. Leakage rates showed a rather dramatic reduction.

6. Friction loss was reduced significantly in the flow ranges of normal forestry use.

7. Synthetic jackets were mildew proof.

8. Weight reductions were substantial.

9. Evaluation users stated a strong preference over linen.

DISADVANTAGES

1. Dry hose was subject to severe damage from hot sparks, embers, and coals.

2. Well-wetted pressurized hose was laid on live charcoal briquets without apparent damage, but melted through when rotated or moved.

3. Synthetic hose fibers melted consistently when an 800°F test slug was laid on charged hose. Linen was not affected.

4. Abrasion, or jacket wear, from dragging over road surfaces, stream bottoms, and glaciated or volcanic soils, caused severe damage to single-jacketed-synthetic hose when wet or dry.

Like linen, the synthetic hose does not lend itself to general tanker use. The heat and abrasion limitations of unlined, synthetic jackets tends to limit use of this construction. To date, a specification is not available for synthetic hose, neither is it stocked by GSA.

4.1.6 - HIGH PRESSURE. Rubber-lined, rubber-covered, high-pressure hose (also called booster hose) is used as "hardline" on tanker live reels. Forest Service Specification 185 requires a heavy-duty noncollapsible water hose of braided and molded construction. This hose is designed for use on hot firelines with little possibility of damage. The hose can be wiped off with a dry rag after use. Abrasion resistance is high, and the exterior covering is not readily damaged by usual solvents.

A 3/4-in. ID high-pressure hose is available in 50-ft coupled lengths. Lengths of 100-ft are available through commercial fire supply houses.

If flows above 35 gpm are planned, a 1-in. ID hose should be used.

4.1.7 - RELAY-SUPPLY HOSE. A single-jacket relay-supply hose has seen increasing use in the U.S. by fire departments. The single-jacket, made of all-synthetic fibers, is coated inside and out with a thin protective coating. The hose is available in $3\frac{1}{2}$-, 4-, $4\frac{1}{2}$-, 5- and 6-inch diameters, and is often coupled with a lightweight aluminum alloy quick-connect coupling of European manufacture. This European coupling may be difficult to connect and disconnect and has a poor configuration for general forestry use.

The hose is intended for supply line use only from a water source to the tanker (pumper). It is not intended to move large volumes of water long distances, and never to a manifold or on the discharge side of a tanker (pumper). Limited use has been made of this hose at airtanker bases for loading. Usually this hose performs poorly when subjected to a kink test.

NFPA suggests the following hydrostatic pressure tests for relay-supply hose:

Trade Size	Proof Pressure Test (psi)	Burst Test (psi)	Kink Test (psi)
$3\frac{1}{2}$	400	600	250
4	400	600	250
$4\frac{1}{2}$	400	600	250
5	300	500	200
6	300	500	200

4.1.8 - ALUMINUM IRRIGATION TUBING. Commercial irrigation tubing (pipe) has seen limited use on prescribed burns, a few fires, and for retardant distribution lines at airtanker bases. Most piping is designed for level farm land use and care should be taken that the tubing used have burst pressures of at least 400 to 600 psi. (See Sprinkler System Protects Fireline Perimeter in Slash Burning, by W. J. Orr and J. D. Dell, Fire Control Notes, USDA Forest Service, October 1964, Vol. 28, No. 4.)

4.1.9 - GARDEN HOSE. Garden hose is not recommended for general fire use even though it has been used in some areas. Difficulty in maintaining standard working pressures, and the uncertainty of buying premium products, make this use hazardous. When garden hose is pressurized, a "scissor-like" condition occurs that increases the diameter and shortens the hose significantly. This can cause coupling failures, and when on hose reels, damage in and around the reel hub attachment, and failure of some reel hubs.

4.1.10 - SUCTION HOSE. Hard-suction draft hose is used on all tankers and with all portable pumpers. Forest Service Specification 184 requires that the hose be constructed of a natural or synthetic-rubber tube; a jacket consisting of a carcass of cotton warp yarns or other suitable yarns interwoven with a helix or helixes of round spring temper wire and fillers of yarns alternately spaced; and a synthetic-rubber outer covering. The coupled hose is designed for a hydrostatic proof pressure test of 300 psi and a vacuum of 20 inches of mercury (22.66 ft) without internal blistering, undue distortion, or leakage. Unless otherwise noted, suction hose will be furnished in 8-ft coupled lengths (overall) by GSA. Diameters and weights are in accordance with the following table:

Nominal Internal Diameter (Inches)	Maximum External Diameter (Inches)	Maximum Weight Lbs per Foot Without Couplings
1	1-9/16	1.0
1½	2-1/16	1.2
2	2-5/8	1.6
2½	3-3/16	2.3

An exception is made on the suction hose for the Model 10 Tanker. For this unit only, a 25-ft section of 3/4-in. ID high-pressure fire hose is supplied (see 2.1.1--5).

Soft suction is now widely accepted in fire department practice where pumpers connect directly to hydrants. The weight savings and flexibility of these $2\frac{1}{2}$-in. to 5-in. diameters is a significant factor.

4.2 - CONSTRUCTION AND MATERIALS. The nominal outside diameters of all jacketed hose furnished under Forest Service specifications are controlled. A saving thereby results, since all coupling bowls for all jacketed hoses are identical and interchangeable. The OD for 1-in. hose is $1\frac{1}{4}$-in. and for $1\frac{1}{2}$-in. hose it is 1-3/4-in. In general fire department practice the ID is controlled and the OD varies with the jacket thickness, the type of liner, and other variables.

Jacketed fire hose elongates when pressurized. Most hose also twists under working pressure, and the direction of twist must be to tighten, not loosen, the couplings. Jacketed hose also tends to warp and rise. For example, a cotton-synthetic jacket in a 50-ft length should not warp more than 25-in. from a straight line nor rise more than 8-in. when pressurized to 450 psi.

Hose is inspected at the time of procurement and may be submitted to the San Dimas Equipment Development Center for prequalification tests.

A list of prequalified hose is available at San Dimas.

4.3 - FLOW VERSUS HOSE DIAMETER. Fire hose type and size must be carefully selected for practical fireline situations. Pump performance, tank size, fire stream required, and the length of hoselay are some of the factors. The nozzle pressure (NP) needed, head involved, and friction loss are of immediate concern. The NFPA Fire Protection Handbook (section 12-29, 13th edition) presents the following guidelines on standard diameters of rubber-lined fire hose in lengths up to 600 ft:

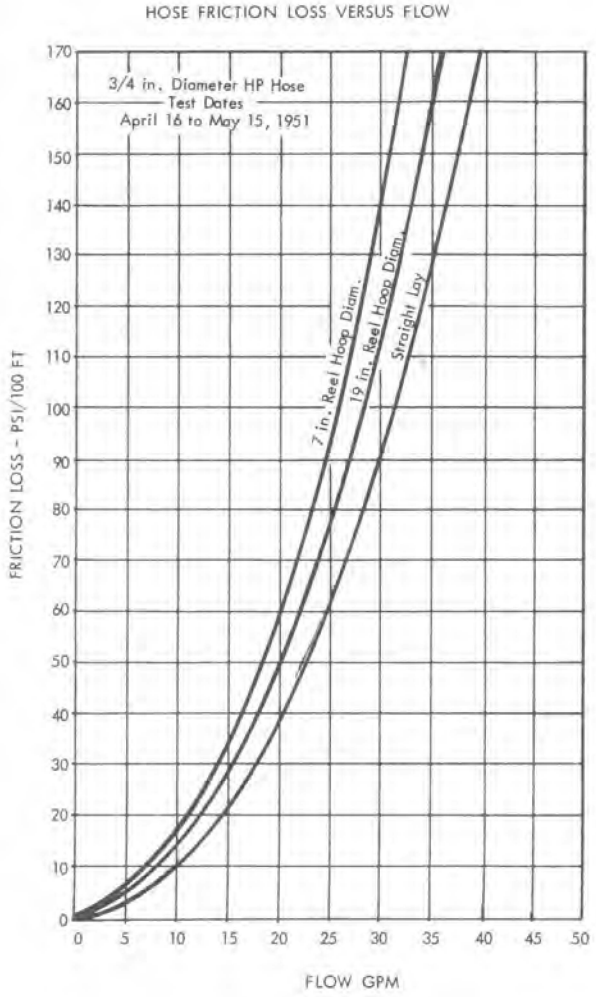
Nominal Hose Diameter (Inches)	Maximum Efficient Water Capacity (Gpm)
1	30
$1\frac{1}{2}$	100
$2\frac{1}{2}$	300

Based on the above principles the practical maximum flow to expect from 300 ft of reeled 3/4-in. ID hard line hose is about 35 gpm. Bear in mind also that the above deliveries do not allow for head losses, i.e., 0.434 lbs loss for each one foot rise in elevation.

4.4 - FRICTION LOSS. Friction loss is the resulting resistance as water (fluids) move along the inside wall of either fire hose or pipe.

Points to Remember

- Friction loss increases as flow (gpm) increases
- Total friction loss varies with the length
- Friction loss varies with the type, quality, and age of hose
- Friction loss is nearly independent of pressure
- Friction losses on reeled hose average about 21% more than for straight hoselays (see chart: Hose Friction Loss vs Flow Curve).



In the following table the friction loss for 100 ft of hose is shown for varying flows and different types. These data were extracted from Forest Service tests and vary from NFPA tables because of differences in hose ID's, elasticity, and liner. These friction losses are consistently lower than those reported by several manufacturers.

FRICTION LOSS IN LBS/100 FT OF HOSE*

	Hose Size (ID) Type					
Flow (gpm)	1/2" G.H.P.	3/4" H.P.	1" CJRL	1-1/2" CJRL	1-1/2" Linen	2-1/2" (Lined)
5	22	3.5				
10	75	13	3.0		1.0	
15	155	25	6.0	1.0	2.2	
20		42	10	1.5	3.6	
25		62	15	2.5	5.5	
30		86	20	3.5	8.0	
40		140	34	5.5	13	
50		215	50	8.0	20	
60			70	11	28	
70			90	15	37	
80			115	19	47	
90			140	23	59	
100			170	30	72	2.5
150						5.8
200						10.1

The $\frac{1}{2}$-in. hose represents friction loss in garden hose. The 3/4-, 1-, $1\frac{1}{2}$-in. CJRL and $1\frac{1}{2}$-in. linen were Forest Service specification hose in straight lays. The $2\frac{1}{2}$-in. data was lifted from Table 12-2A of the NFPA Fire Protection Handbook for large hose comparison.

Friction reducing agents are available and are under evaluation. They are formulated to not only reduce losses in a given hose diameter but also to reduce hose size, weight, and cost and still retain the same performance. The logistics and engineering equipment for metering friction reducing agents into the pump or hose line have not yet been perfected.

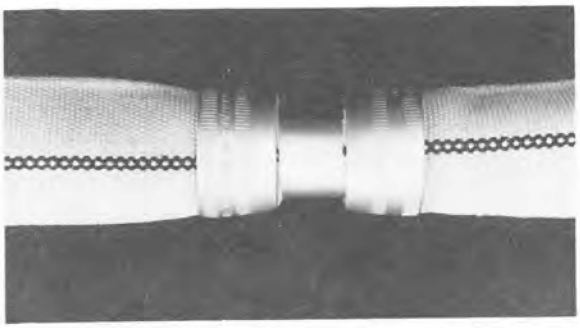
*See Table 4, page 10, "Capacities of and Pressure Losses Through Reeled and Unreeled Small-Diameter Hoses, "U.S.D.A. - Forest Service, E.D. Report No. 28, October 1954. Also see the pocket-sized, inexpensive "Nozzle Discharge and Friction Loss Calculator" described on page 7.1.

4.5 - COMPARATIVE DIAMETERS AND WEIGHTS (100-ft Lengths Uncoupled)

Type of Hose	FS Spec.	Jacket	ID (Inches)	Working Pressure (PSI)	Max. Dry Weight	Gallons Water	Weight Water (lb)	Max. Total Weight (lb)
Garden (Comm.gr.)	None	-	5/8	125	28	1.6	13	41
High pressure (reel)	185	-	3/4	425	50	2.3	19	69
High pressure (reel)	None	-	1	-	53	4.1	34	87
Cotton-jacket, rubber-lined	182	Sgl.	1	300	28	4.1	34	62
Cotton-synthetic jacket, rubber-lined	5100-00186	Sgl.	1	450	22	4.1	34	56
Unlined (linen)	5100-183	Sgl.	1	300	10	4.1	34	44
Cotton-jacket, rubber-lined	182	Sgl.	1½	300	33	9.2	77	110
Cotton-synthetic jacket, rubber-lined	5100-00186	Sgl.	1½	450	26	9.2	77	103
Unlined (linen)	5100-183	Sgl.	1½	300	15½	9.2	77	92
Cotton-synthetic jacket, rubber-lined (light tube)	None	Dbl.	2½	-	58 to 160	25.5	213	271 to 373

The actual weight of the small diameter jacketed fire hose is usually 1 to 3 lbs less than the maximum dry weight given. Coupling sets (1½-in.) vary in weight from 0.9 to 1.6 lbs.

4.6 - HOSE MENDERS. A "Fire Hose Mender" is available for installation on certain lightweight unlined-jackets. The mender is designed for field repairs (see "A Fire Hose Mender," Equip Tips, October 1971).



4.7 - TABLES, CONVERSION FACTORS, AND RULES OF THUMB.

Tables showing pump pressures required for 50 and 100 lbs nozzle pressure for varying lengths of hoselays, at varying elevations, for common sizes of nozzle tips are available in Section 10.

NOZZLES

5.0 - GENERAL. Standards for hand-tool fireline construction are designated by cover types. These standards establish the width of the fireline needed, based largely on height of cover and flamability.

In structural fires firemen size up the volume and contents of a room or building and use rough guidelines to determine fire stream requirements. Rough rules of thumb, however, are nearly non-existent for measuring knockdown capability in forest, brush, and grass fuels. For some time decisions on tanker size, water flow requirements, and nozzle performance have been directed towards easy forestry mop-up assignments. A more realistic approach is shaping among aggressive rural fire agencies which looks for fire knockdown capability on "running" and "spotting" firelines. It follows that if these difficult assignments are handled adequately the mop-up work on "smoldering" and "creeping" surface fires will be comparatively easy. A review of section 1.0 may be helpful.

The typical fire department with an adequate hydrant system will usually use a nozzle with high-flow characteristics to support the traditional principle of using the maximum water available. On the other hand, the traditional rural unit will ask for a miserly stream or pattern in order to conserve water and reduce travel back to the nearest water "chance." A wide range of nozzles and tips have been made available by manufacturers to meet this wide range of application.

5.1 - DESIGN CRITERIA. The ABC's of nozzle selection for forest fire use (see section 1.1) also give careful consideration to the water load, the pump, and the hoselay. Since small-diameter hose lines are usually employed, this material will be directed largely to nozzles for handlines in the booster reel class (3/4" & 1" I.D.'s).

The following design or selection criteria have evolved from many years of forestry practice and numerous detailed studies.

1. Rate of Application. Roughly, flow is limited to about 35 gpm for 3/4" and 1" I.D. lines and to 100 gpm for the 1-1/2" lines. Additional research is needed on flow vs. cover types.

2. Right Form. Combination nozzles that provide both straight streams and spray patterns are usually required. Standard spray tips are available from 3 gpm to 24 gpm. Numerous adjustable nozzles, of course, go to much higher flows. Ability to vary the spray is important.

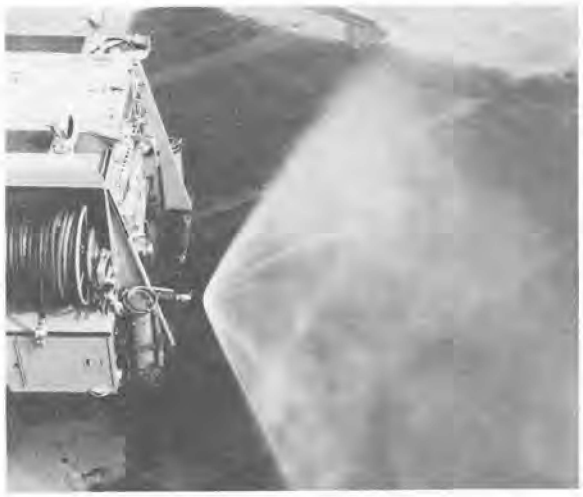
Clean, variable straight-streams are required for the full range of working pressures.

Straight-stream tips range from 1/8" to 1/2" in general practice.

While combination features are desirable, some nozzles show a wide range of discharge, i.e., flows increasing with the spray cone angle.

This characteristic is undesirable.

3. Good Pattern. Some nozzles produce solid cone patterns, which is the most desirable. Others have distinct hollow cones (see photograph), voids, and flat, fan-shaped patterns. Some sprays look like the ribs of an umbrella as water is projected in jet streams. These latter patterns are wasteful of water and may result in skips in water line firefighting.



4. Water Droplet Size. Fine sprays offer better cooling and give protection to nozzlemen from excessive fire temperatures. Water droplets should be in the size range of 0.35 mm to 1.0 mm to be most effective. Nozzles should also produce an acceptably uniform droplet size over a reasonably wide range of pressures. Finely divided sprays, however, may not reach as far as required and may be severely buffeted and dissipated by winds and updrafts.

5. Nozzle Pressures. "Recommended pump . . . pressure for low-pressure fog nozzles on booster lines is 100 psi at the nozzle, plus an amount for friction loss and an amount necessary to overcome any loss due to elevation."* In actual use on longer hoselays, nozzle pressure may vary from 50 to 150 psi. The flow and horizontal range for the nozzles in this section have been related to 100 psi nozzle pressure.

*See page 12-31, NFPA Fire Protection Handbook.

Flow is reduced to about 7/10 when the nozzle pressure is reduced from 100 to 50 psi. One can use a 3/4 rule when pressure is reduced from 100 to 56 psi.* (See section 10.3).

6. Control Valves. Shutoff features, and flow and pattern variations, are controlled by lever-type ball valves, by rotating the body of the nozzle, or by trigger action. Nozzles are marked, indexed, or referenced so that efficient operation is possible, even to an inexperienced fireman.

7. Tips. If flows and patterns are varied by exchanging tips, the tips will be provided with 3/4" G.H. threads and meet the requirements of Forest Service Specification 5100-244.

8. Clogging. Since forestry tankers pick up water in open sources at the nearest water chance, foreign matter and silt are often a problem. Spray nozzles should be equipped with adequate screens that can be easily removed and serviced.

9. Base Inlet. All booster nozzles are provided with 1" I.P. (1--11½ NPSH) threads. There is limited need for 1½" base nozzles using 1½" N.S. (1½--9NH) thread. Rocker lugs or a knurled base are required.

10. Weight. Weight is an important factor, so lightweight materials are desirable. Some heavy brass nozzles are thus eliminated from practical forestry use. Nozzles should preferably weigh no more than two pounds.

11. Cost. Simple, trouble-free construction providing the performance listed in items 1 through 10 is necessary. Expensive materials, such as copper-bearing brass, and highly polished or plated hardware and accessories, are neither required nor desired for forestry use.

A representative forestry nozzle in widespread use that meets most of the above requirements is available under Forest Service Specification 5100-240 (Nozzle, Twin-Tip, Shutoff, 1-inch Base, Straight-stream and Fog Tips). This nozzle is furnished by Federal Supply Service as catalog item FSN 4210-640-1892.

5.2 - TYPES OF NOZZLES. For simplicity, nozzles can be grouped into several broad classes. If the nozzle can produce either a straight-stream or a spray selectively it is classed as a combination type. A few nozzles can produce both patterns simultaneously, but their flow requirements are high. The more common types are listed:

1. Adjustable combination

   Example: Lightweight plastic (Lexan) combination (see 5.5.1).

*NFPA 1962, Operating Fire Department Pumpers, page 83.

2. Plain

   Example: Plain screw-tip (see 5.5.2)

3. Select tip combination shutoff

   Example: "Forester" Six-shooter Nozzle (see 5.5.3)

4. Single tip shutoff

   Example: One-inch shutoff with tips (see 5.5.4)

5. Twin tip combination shutoff

   Example: One-inch shutoff combination fog and straight-stream (see Spec. 5100-240 and section 5.5.5)

Foam nozzles have very limited use in forestry practice because the harsh fire environment of wind and vegetation tend to break up the foam bubbles rapidly. A simple system is described in section 7.3.

True fog nozzles require pressures of 400 psi to 850 psi for effective operation. Few forestry pumps or tankers are capable of developing these nozzle pressures. Three forestry pumps that do have this capability are the John Bean Model 101-FD, the CEDCO Model A10F, and the Model 60 PTO tanker. Fog nozzles are attached to high-pressure hose-reel lines.

5.3 - NOZZLE TIPS. In fire department practice both $2\frac{1}{4}$" and $1\frac{1}{2}$" nozzle shutoff valves have $1\frac{1}{2}$" standard fire-hose threads for both the inlet and outlet sides (see NFPA No. 194, section B-211, -212, and -213). Since forestry tips are comparatively small (1/8" to 1/2" primarily) a 3/4" G.H.T. has been adopted (3/4--$11\frac{1}{2}$NH) for the base thread.

The Forest Service maintains Specification 5100-244 on straight-stream and spray tips. This specification lists five different base-diameter straight-stream tips and eight different flows (gpm) in spray tips. The bore diameter is on the outlet flange of the straight-stream tips, and the flow (gpm) is stamped on the tip barrel of the spray tips. The tips are made of noncorrosive material and designed to withstand a pressure of 600 psi. Materials and construction are spelled out in detail.

5.3.1 - STRAIGHT-STREAM TIPS. Straight-stream tips are designed and inspected to produce the following minimum performance:

Tip Size Inches	Minimum Stream length* @ 100 psi (feet)	Flow Rate @ 100 psi Minimum (gpm)	Flow Rate @ 100 psi Maximum (gpm)
1/8	29	4.2	5.2
3/16	34	9.4	11.6
1/4	40	16.8	20.6
5/16	41	25.3	32.1
3/8	41	37.9	46.3

*Measured 36" above the ground and to the center of the area where the stream strikes the ground.

5.3.2 - SPRAY TIPS. The spray requirements specify a uniform solid-cone mist with a minimum horizontal range of 12 feet. The flow rate at a tip pressure of 100 psi, must be within the range shown in the following table:

Tip Number (gpm)	Discharge Angle (Deg.) Minimum	Discharge Angle (Deg.) Maximum	Flow Rate (gpm) Minimum	Flow Rate (gpm) Maximum
3	18	22	2.0	4.0
6	18	22	5.0	7.0
8	18	22	7.0	9.0
9	26	30	8.0	10.0
12	26	30	11.0	13.0
15	26	30	13.5	16.5
18	26	30	16.5	19.5
24	26	30	22.5	25.5

5.3.3 - ADJUSTABLE TIPS. Premium garden hose nozzles are often used as tips on booster line nozzles, especially for mop-up work. Forest Service Specification 243 calls out first-class material and construction capable of working pressures of 250 psi with no leakage in any adjusted position. Overall maximum length is 5" in the shutoff position; weight does not exceed 14 ounces.

Position	Discharge in gpm @ 100 psi Minimum	Maximum
1. High-velocity, low-discharge, wide-angle spray	6	7
2. Straight-stream	$4\frac{1}{2}$	$5\frac{1}{2}$
3. Low-Velocity, high-discharge spray	$9\frac{1}{2}$	$10\frac{1}{2}$

Firemen should observe the low working pressure requirements of this tip.

5.4 - APPLICATOR PIPE. An applicator pipe, or wand, is available for reaching under logs, roots, stumps, and into the base of piled fuels. It can be used in deep duff, peat, and sawdust. The applicator is 48" long, has a 45° bend near the end, and is equipped with 3/4" GHT at the inlet. The discharge end has 3/4" GHT male threads to accomodate a special low-flow spray tip (3 gpm with a 60° pattern).

5.5 - NOZZLE DESCRIPTIONS. A dozen or so commonly used booster nozzles with 1" bases have been included for reference purposes. Several plain nozzles with $1\frac{1}{2}$" bases are also added. The information has been established in brief descriptive format. Factual test information has been included when available.

NAME: AKR-O-JET FOG NOZZLE; STYLE 1201

TYPE: Adjustable Combination barrel with double shutoff.

ACTION: Sequence from Shutoff-Fog-S.S.-Shutoff

MANUFACTURER: Akron

CATALOG NO: Style 1201

WEIGHT: 2-1/4 lbs

LENGTH: 4-3/4 in.

BASE (INLET): 1" I.P. Thread with two Rocker lugs.

FINISH: Wire brush (or chrome-plated).

MATERIAL: Brass body with rubber bumper.

PATTERNS:

Straight-stream Tests

25 gpm @ 100 psi;
50 ft horizontal reach.*

Spray Pattern Tests

Setting	Gpm @ 100 psi	Cone Angle
1	27	30°
2	42	60°

*Test patterns taken at 4 ft level.

PURCHASE: Federal Stock No. for open market purchase: 4210-537-3117.

NAME: ELKHART INDUSTRIAL NOZZLE

TYPE: Adjustable combination barrel with shutoff

ACTION: Sequence is from shutoff through fine spray to coarse spray and straight-stream.

MANUFACTURER: Elkhart

CATALOG NO: S-205-B

WEIGHT: 2 lbs, 11 oz

LENGTH: $4\frac{1}{2}$"

BASE (INLET): 1" I.P. Thread with two Rocker lugs.

FINISH: Polished brass

MATERIAL: Brass

PATTERNS: Catalog lists two flow selections, 12 or 23 gpm.

Straight-stream Test

17 gpm @ 100 psi; 42 ft horizontal reach

Spray Pattern Tests

Setting	Gpm @ 100 psi	Cone Angle
$1\frac{1}{2}$	42	105
2	41	102
3	36	100
4	22	50

Spray pattern was a double cone.

Also note flow is nearly doubled at widest cone angle.

NAME: ELKHART STANDARD MYSTERY NOZZLE

TYPE: Adjustable combination barrel with shutoff

ACTION: Sequence is shutoff through straight-stream to fine sprays in 270° of rotation.

MANUFACTURER: Elkhart

CATALOG NO: S-200

WEIGHT: 3 lbs, 8 oz

LENGTH: 4-3/4"

BASE (INLET): 1" I.P. Thread with two Rocker lugs.

FINISH: Polished brass

MATERIAL: Brass

PATTERNS: Catalog lists two flow selections 12 or 23 gpm.

	Spray Pattern Tests		
Straight-stream Test	Setting	Gpm @ 100 psi	Cone Angle
22 gpm @ 100 psi; 50 ft horizontal	4	31	60
	5	54	115

NAME: SIERRA RANGER NOZZLE (KK)

TYPE: Adjustable combination barrel with shutoff

ACTION: Sequence from wide angle spray, to 20 gpm straight-stream, to 10 gpm straight-stream to shutoff.

SOURCE: Halprin Fire Supply

CATALOG NO: D-1020

LENGTH: 4" Overall

BASE (INLET): 1" I.P. Threads; knurled base

FINISH: Anodized (Maroon color)

MATERIAL: Lightweight aluminum with stainless steel discharge components.

PATTERNS:

Nozzle setting	1	2	3	4	5	6	7	8	9
Cone Angle	114°	104°	60°	6°	S-S*	S-S**	14°	S-S	Shutoff
Flow @ 100 psi	50.3	44.3	29.8	24.4	21.8	21.2	10.6	9.9	0

* Horizontal range at 150 psi was 60 ft.

** Horizontal range at 150 psi was 50-55 ft.

NOTE: Nozzle setting #1 was full open wide angle spray. No. 1 through #9 in $\frac{1}{4}$ turn increments. Setting #9 was shut-off (two full turns from #1, open).

NAME: VARI-A-FOG NOZZLE

TYPE: Adjustable combination barrel with shutoff

ACTION: Sequence from shutoff to straight-stream to spray patterns.

MANUFACTURER: Wooster

CATALOG NO: NIF-10

WEIGHT: 2 lbs, 5 oz

LENGTH: 4-3/8"

BASE (INLET): 1" I.P. Thread with two Rocker lugs.

FINISH: Polished brass

MATERIAL: Brass

PATTERNS: Catalog lists several flow choices:

Straight-stream Test	Setting	Spray Pattern Tests: Gpm @ 100 psi	Spray Pattern Tests: Cone Angle	Remarks
5 gpm @ 100 psi; 35 ft horizontal reach.	3	25	10	Semi-hollow cone
Straight-stream flows varied from 5, to 22 gpm, depending on the the setting.	2	40	80	"
	1	40	90	Hollow cone

NAME: WILCO PLASTIC COMBINATION NOZZLE

TYPE: Adjustable combination barrel with shutoff.

ACTION: Sequence is from shutoff to straight-stream to spray in one full turn of the barrel.

FEDERAL SUPPLY SERVICE: FSN 4210-08R-3608

SOURCE: Purex, Prosser-East

CATALOG NO: HN-1-L

WEIGHT: 5 oz

LENGTH: $4\frac{1}{2}$"

BASE (INLET): 1" I.P.T.

FINISH: Smooth plastic with small ribs.

MATERIAL: Plastic (Lexan) with rubber bumper. Spindle is brass.

PATTERNS: GSA stocks only the 17 to 20 gpm flow @ 100 psi. However, the manufacturer also provides a larger flow @ 33 to 35 gpm. The cone angle is adjustable from a wide angle to a straight-stream.

REMARKS: Lightweight feature makes this nozzle ideal for hose pack use. Corrosion proof, except for brass spindle and nut. Low cost makes this nozzle attractive where losses may be high.

NAME: PLAIN SCREW TIP NOZZLE

TYPE: $1\frac{1}{2}$" plain nozzle with spare tip carrier on side of body. Outlet end threaded for G.H.T. tips as provided under F.S. Specification 5100-244 (Tips, Straight-stream and Spray). Designed for working portable pumper hoselays with pressures of 300 psi.

FEDERAL SUPPLY SERVICE: 4210-082-5680

MANUFACTURER: Western Fire Equipment Co.

CATALOG NO: 14 X 570

WEIGHT: 2 lbs, 6 oz (with tips)

LENGTH: 7-3/4" overall

BASE (INLET): 1-1/2" N.S.T. ($1\frac{1}{2}$--9NH)

FINISH: Smooth, sand-cast exterior

MATERIAL: Brass

PATTERNS: Furnished by Federal Supply Service with 1/4", 3/16", and 3/8" tips. The plain-nozzle body discharge-end without a tip provides an accurately machined 1/2" bore opening.

Equipment Development Center tests were as follows:

Tip Size (In.)	Gpm @ 100 psi	Horizontal Reach (ft.)
3/16	10	38
1/4	17	42
3/8	41	-

NAME: WILCO PLAIN FORESTRY PIPE NOZZLE

TYPE: $1\frac{1}{2}$" base plain nozzle made from Lexan plastics with two spare tips attached to the garden hose threaded tips. Designed for portable pumper hoselays.

SOURCE: Purex, Prosser East

CATALOG NO: HN 40-L

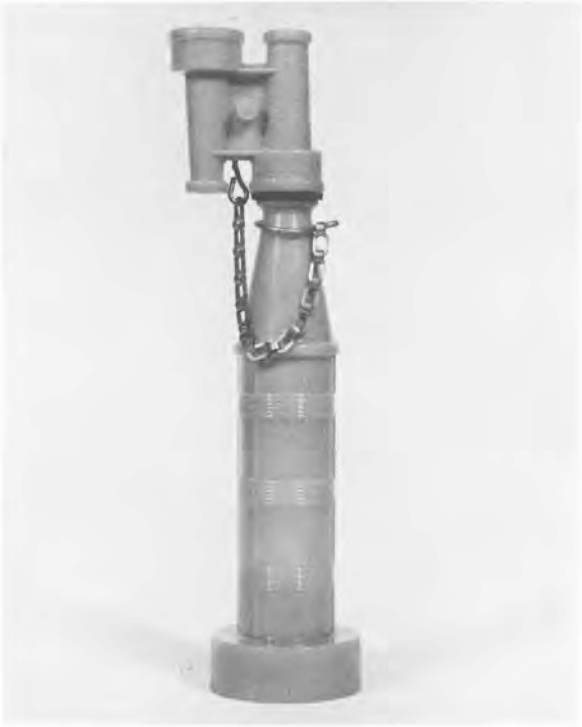
WEIGHT: 6 oz (with tips)

LENGTH: 10" overall (with tips)

BASE (INLET): $1\frac{1}{2}$" N.S.T. with smooth base.

FINISH: Smooth orange plastic

MATERIAL: Plastic (Lexan) with brass chain. Tips of same material.



PATTERNS:

Tips (In)	gpm @ 100 psi	Horizontal Reach (ft)
$\frac{1}{4}$ (tip)	19.5	45 to 50
3/8 (tip)	37.4	55 to 60
$\frac{1}{2}$ (nozzle)	58.8	-

The above performance is representative but not conclusive since the figures are based on one test and with one production nozzle.

NAME: FORESTER "SIX SHOOTER" NOZZLE

TYPE: Select-tip combination with shutoff; combination solid cone spray and straight-stream.

ACTION: Sequence from "S-S" to "fog" to "closed"; "forward" position is closed to simplify when dragging hose.

MANUFACTURER: Western Fire Equipment Co.

CATALOG NO: 4A785

WEIGHT: 2 lbs, 14 oz

LENGTH: 5-3/4" overall

BASE (INLET): 1" I.P. Thread knurled base

FINISH: Brushed aluminum

MATERIAL: Aluminum alloy body; brass parts; stainless steel threaded insert base

PATTERNS: Designed with a revolving head with a series of six marked precision orifice openings providing six straight-streams and six spray (fog) patterns.

TESTS: Forest Service tests were conducted in 1969. Straight-stream patterns were found to be generally well-shaped; spray patterns were solid cones. Results of the tests were as follows:

Straight-stream Test			Spray (fog) Patterns		
Orifice Size (in.)	Gpm @ 100 psi	Horizontal Reach (ft)	Size	Gpm @ 100 psi	Cone Angle
1/8	3	35	F3	3	25°
5/32	6	35	F6	6	25°
3/16	9	38	F9	9	35°
1/4	13	42	F12	12	45°
5/16	20	48	F15	15	55°
3/8	34	43	F18	18	60°

NAME: SINGLE-TIP SHUTOFF NOZZLE

TYPE: Single-tip shutoff; straight-stream waterway with ball valve shutoff and threaded outlet for Forest Service tips.

DESCRIPTION: Designed to provide an inexpensive shutoff nozzle with interchangeable straight-stream tips. Lack of spray pattern should be considered when buying this nozzle. Recommended maximum working pressure is 300 psi.

ACTION: Lever sequence from "open" to "shutoff" (lever forward position).

FEDERAL SUPPLY SERVICE: FSN 4210-203-3519

MANUFACTURER: Camcone

WEIGHT: 1 lb, 15 oz (with one tip)

LENGTH: 4-1/2"

BASE (INLET): 1" I.P. Thread with knurled band

FINISH: Brass

MATERIAL: Body and base of brass; tips as per separate Forest Service Specification.

SPECIFICATIONS: This nozzle is purchased under Forest Service Specification 241 (Shutoff Nozzle) and is stocked by GSA (see FSN above). Supplied with 3/16", 1/4", and 3/8" tips under Forest Service Specification 5100-244 (Tips, Straight-stream and spray).

NAME: R-5 FORESTER FOG-STREAM (TWIN TIP) NOZZLE

TYPE: Twin tip combination shutoff; twin threaded tip with solid cone spray, straight-stream (S-S), and shutoff positions.

DESCRIPTION: This nozzle is equipped with a three-position valve and two parallel outlets so that a straight-stream or a finely divided spray can be used. Six S-S tips and eight spray tips are available. Tested up to 600 psi. Outlet threads for tips are 3/4" G.H. Threads.

All water passing through the fog-spray tips goes through a self-cleaning Monel strainer.

ACTION: Lever-action sequence from shutoff to spray to straight-stream.

FEDERAL SUPPLY SERVICE: FSN 4210-640-1892

MANUFACTURER: Western Fire Equipment Co., and A. V. Barron Machine Co.

CATALOG NO: 4A500 (Western Fire)

WEIGHT: 1 lb, 10 oz (plus tips)

LENGTH: 7-in. assembled

BASE (INLET): 1-in. IP Thread; knurled base

FINISH: Brushed aluminum body, brushed chrome tips

MATERIAL: Lightweight aluminum

SPECIFICATIONS: These nozzles are purchased under Forest Service Specification 5100-240 (Nozzle, Twin-tip, Shutoff, 1" Base) and are stocked by GSA. The tips are also purchased and stocked by GSA under Forest Service Specification 5100-244 (Tips, Straight-stream and Fog (spray). Each nozzle from GSA comes with a 3/16" and 3/8" S-S tip and the 3- and 6- GPM spray tip.

PERFORMANCE: Under the specification the Twin-tip Shutoff nozzle is furnished as a prequalified item through GSA. Tests are conducted at San Dimas Equipment Development Center and may be tested by GSA at time of purchase.

Tips are furnished and tested in accordance with Forest Service Specification 5100-244 (see section 5.3). The following information is from the Western Fire Equipment Co.'s description:

Type Tip	Size Tip	Gpm @ 100 psi	Pattern	FSN No.
Straight-stream	1/8"	5	32'	See Mfr.
" "	5/32"	7	35'	" "
" "	3/16"	10½	38'	4210-203-3855
" "	1/4"	19	42'	4210-177-6135
" "	5/16"	29	46'	See Mfr.
" "	3/8"	42	49'	4210-203-3845
Spray-Std. Narrow Pattern	3 gpm	3	18°	4210-204-3358
" " " "	6 gpm	6	18°	4210-204-3386
" " " "	8 gpm	8	18°	See Mfr.
Spray-Spec. Board Pattern	9	9	30°	See Mfr.
" " " "	12	12	30°	" "
" " " "	15	15	30°	" "
" " " "	18	18	30°	" "
" " " "	24	24	30°	" "
" " " "	3*	3	60°	" "

*This spray tip produces solid cone patterns.

NAME: FORESTRY NOZZLE; STYLE 1055

TYPE: Twin tip combination shutoff; twin-threaded tips with one solid-cone spray tip and three straight-stream tips.

ACTION: Entire body of nozzle swivels on the base; sequence from shut to fog to straight-stream in a clock-wise direction.

MANUFACTURER: Akron

CATALOG NO: Style 1055

WEIGHT: 2 lbs, 1 oz (with two tips)

LENGTH: 7-3/4"

BASE (INLET): 1" I.P. Thread with two Rocker lugs

FINISH: Cast aluminum

MATERIAL: Lightweight Akrolite aluminum body.

TEST PATTERNS:

Straight-streams

Tip Size (In.)	Gpm @ 100 psi	Horizontal Reach (ft)
1/8	3	32
3/16	9	38
1/4	13	35

Spray (Fog) Pattern

Size	Gpm @ 100 psi	Cone Angle
Fog	10	60°

FITTINGS, CONNECTIONS, AND THREADS FOR FIRE HOSE LINES

6.0 - FITTINGS AND CONNECTIONS. This section includes the many different types of couplings, connections, adapters, increasers, reducers, wyes, and valves required in forestry fire hose lines. If the item makes up into, or attaches to, a fire hose line, it should be found here.

TERMINOLOGY. It is important to know what is commercially available, what the item is usually called, and where hard-to-get items can be found. Terminology in the latter part of this section has been established after a careful review of NFPA materials and fire equipment catalogs. It is important that FS personnel establish these terms through everyday usage around water equipment.

6.1 - CONSTRUCTION AND MATERIALS. Brass and bronze materials are a tradition in fire department service. The most commonly used brass alloy composition is often designated as 85-5-5-5, meaning 85 percent copper and 5 percent each of tin, lead, and zinc. Advantages of brass and bronze include their ability to stand up under rugged fireline use, they are easily formed and handled for limited orders, their use results in a good-looking product, and thread engagement is satisfactory. The weight of these materials is a limiting factor in FS use, and most fire chemicals are highly corrosive to brass.

Aluminum alloys are finding a substantial place in forestry use. These alloys are usually about 90 percent aluminum and 7 percent zinc. Copper, iron, magnesium, manganese, and nickel are found in varying amounts. These alloys are about 1/3 of the weight of brass, an important consideration. Threads in FS practice are hard-coated to prevent thread seizure and galvanic action (FS Interim Specification 5100-00108).

WEIGHT. Since aluminum alloys are about 1/3 of the weight of brass and bronze, use of equipment made with this alloy should be encouraged. This is justified because of the man-packing involved in rough, cross-country forestry practice. Aluminum alloy also tends to be less expensive.

MANUFACTURING METHODS. Couplings and other fittings and connections are usually shaped by forging, extruding, or sand-casting. FS Specification 5100-102a for Fire and Suction Hose Couplings offers two options, forged and sand-cast. The FS requires that the surfaces shall be smooth and free from flash and burrs. Chroming or plating is not justified in FS practice.

6.2 - LUGS. The FS standardized on the rocker lug in 1963. The photo illustrates the many variations found among lugs made by different manufacturers. For this reason the FS calls out in some detail the various dimensions involved. Prior to 1963, the Service used the slotted forestry lug design. A spanner wrench built to the FS specification will fit either the rocker or the slotted forestry lug. Other types of lugs include the "pin," "pin hole," and "long handle."

A knurled, nonslip surface is often used on the base of a nozzle to assist in breaking the connection.

"Hose inlet connections" and "male hose nipples," which make up to rigid pipe, usually have a hexagon surface up to and including 3" diameter. This provides a pipe-wrench grip.

Two or three lugs are usually required on the swivel section of couplings, connections, valves, and wyes. They are acceptable but not required on male coupling sections.

6.3 - FIRE HOSE THREADS. Hose threads are said to be straight, or parallel; and a water seal is formed as the external thread lip seats against a recessed gasket in the internal thread section. In contrast, water-pipe threads are tapered and seal against themselves.

"NH" is an abbreviation of American National fire-hose coupling thread for garden, chemical, and fire protection hose. "NPSH" is the abbreviation for American National hose-coupling threads; i.e., straight pipe threads for hose couplings and nipples.

THREAD STANDARDIZATION. The International Association of Fire Chiefs, the NFPA, and nearly all Federal agencies are actively supporting a Nation-wide thread standardization program. Several states now have laws with enforcement teeth in them. "One manufacturer reported an inventory of 771 different coupling threads for the nine standard sizes of fire hose" (NFPA). Fire agencies are charged for this extravagance. Men have paid with their lives for the confusion that results on fire lines. The Forest Service lost two fire fighters in 1947 while attempting to couple two hose lines together involving the same diameters but different threads.

The Forest Service adopted NFPA standards (NFPA-Std. No. 194, 1968) for 2-1/2" fire hose threads in 1952. In 1961, the Service established a five-year standardization program in 1-1/2" threads, to be completed in all Regions by June 1966 (FS-SDEDC, 1960). There is no current plan to standardize 1", which is presently an Iron Pipe Thread.* A table showing the threads used in current FS practice follows:

Nominal size (inches)	Threads per inch	Maximum major male diameter (inches)	Symbol National Bureau of Standards	Fire thread abbreviation	Thread color code**
2-1/2	7-1/2	3.0686	2-1/2--7-1/2 NH	N.S. Thread	Yellow (or orange)
1-1/2	9	1.9900	1-1/2--9 NH	N.S. Thread	Yellow
1	11-1/2	1.2951	1--11-1/2 NPSH	I.P. Thread	Black
3/4	11-1/2	1.0625	3/4--11-1/2 NPSH	G.H. Thread	Grey (aluminum)

The large 2-1/2" diameter threads are used primarily for suction hose couplings and on loading hose at airtanker chemical bases. The 1-1/2" size is by far the most common in forestry practice and is used for basic leader lines. The 1" connection is used on most nozzle bases, on 1" soft hose, and on 3/4" ID hard rubber lines for reels.

The tips for straight-stream and fog nozzles have 3/4" G.H. Threads (3/4--11-1/2 NPSH) in general forestry practice, as provided in FS Interim Specification 5100-00244. This 3/4" thread is no longer an NFPA standard (NFPA-Std. No. 194, 1968). The FS does not recommend 3/4" garden hose couplings for fire service.

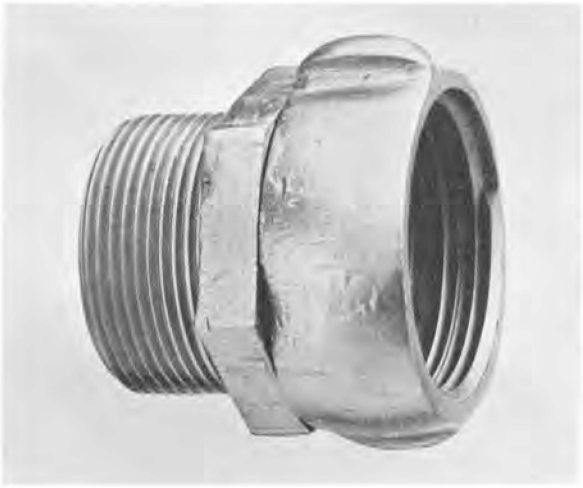
The Northern and Pacific Northwest Regions are using centrifugal portable pumpers with a high flow capability. Under some circumstances it may be advantageous to use 2" suction hose. These orders may be specified as I.P. Thread (2--11-1/2 NPSH) with a maximum major male diameter of 2.3528".

*Also designated as "Straight (parallel) Iron Pipe Threads (SIPT)".

**The California Region has adopted a color code. A narrow stripe of paint is brushed on the male shoulder or swivel of all fittings to designate the type of thread. Chemical thread is coded blue.

3/4" AND 1" CHEMICAL (BOOSTER) HOSE. This size and type of hose is used in fire department practice, and the N.S. Thread used is designated as 1-8 NH (1.375" OD). This thread is also known as chemical or booster hose thread.

HIGBEE CUT. The starting thread on fittings or couplings gets thinner and can lead to thread crossing and mutilation. In order to eliminate this problem and make starting more positive, this thread is cut away or blunted. This is referred to as a Higbee cut. (Also see "Definition, section 1.2.)



6.6 - HOSE INLET CONNECTIONS

are furnished with male (shown) or female tapered pipe threads on one end, with a center hexagon wrench grip for installation on filling tanks, standpipes, and overhead fittings. The opposite end consists of a standard female hose coupling swivel for connecting a fire hose line to a fixed installation. Some fire supply houses furnish "hose inlet connections" also as reducers or increasers. Common example: 1-1/2" N.P. male thread (taper pipe) to 1-1/2" N.S. Thread in cast brass with rocker lugs. Commonly available in 1", 1-1/2", and 2-1/2" sizes.

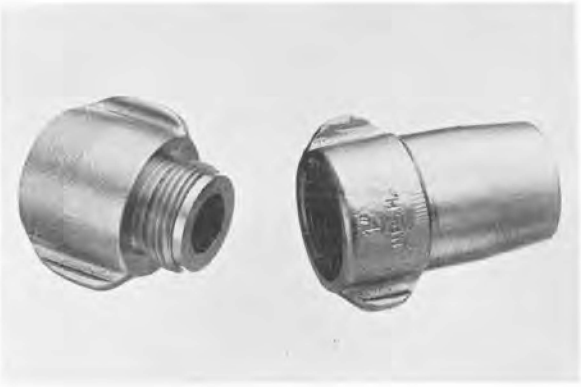
6.7 - COUPLINGS. Couplings are used on all fire hose to provide an easy means of attachment to added lengths, to fittings, or to a nozzle. The portion on the left is known as the swivel, or female section, and that on the right as the male section. Rocker lugs are required on the swivel but are optional on the male section. A carefully sized washer (gasket) is required in the recess of the swivel section to prevent leaking.

Most FS fire hose is purchased with the couplings installed by the hose manufacturer. These brass couplings of the expansion ring type are purchased under FS Specification 5100-102a, which provides that the construction may be either forged or sand-cast, as ordered. Couplings can be furnished only by those manufacturers who have submitted their couplings under the specification for prequalification. The coupling set is tested to 2,000 pounds per inch of nominal hose diameter for qualification purposes.

The FS also has written a Lightweight Fire Hose Coupling Specification, Interim Number 5100-00108; but little use has been made of this one to date. This specification is written around performance for 1" and 1-1/2" couplings for any acceptable material.

The installation of fire hose couplings is a rather critical operation and requires specialized equipment. Recoupling is usually confined to Regional caches and special crews, such as thread conversion teams who have received specific training.

SCREW EXPANDER COUPLING.



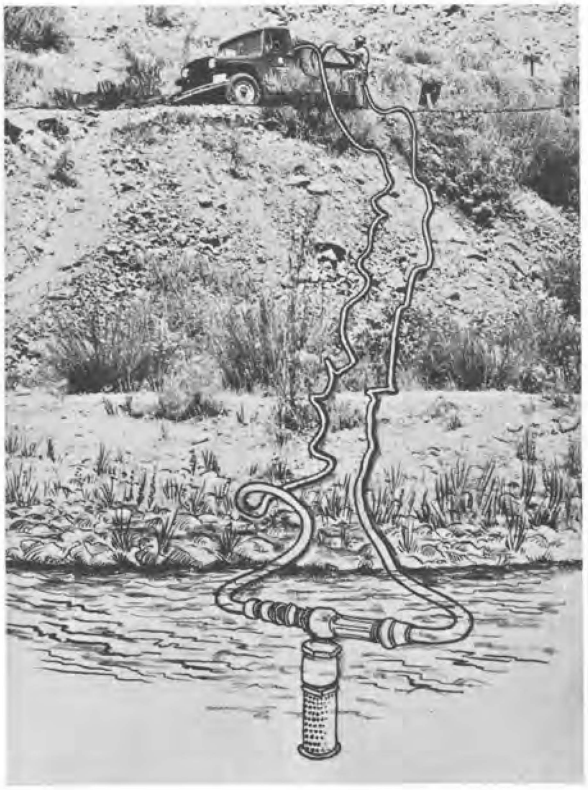
This type of coupling is for use on 3/4" ID high-pressure hose. Utilizes a tapered expander sleeve which screws into the hose bowl to secure the hose and provide a positive seal without the use of a tailpiece gasket. The FS uses 1" I.P. Threads (1"--11-1/2 NPSH) and and rocker lugs in a smooth bronze body. Weight is approximately 24 ounces. Usually supplied in several bowl dimensions to ensure that the coupling and the hose are properly matched. Bowl dimensions are usually indicated by order numbers. These couplings are rather expensive but are reusable.

6.8 - DOUBLE FEMALE COUPLINGS

connect two male sections having the same diameters and threads. Occasionally furnished with different threads and then called a "DOUBLE FEMALE ADAPTER COUPLING." Available in two- or three-piece construction; three-piece suggested so both swivels turn separately. Usually furnished in cast brass.

Available in 1" I.P. Thread and 1-1/2" and 2-1/2" N.S. Thread with rocker lugs.

A 1-1/2" size is also available in a lightweight alloy which weighs 8 ounces and is less expensive (Darley Fire Equipment, Cat. No. J905).



EJECTOR SELECTION. Ejectors should be selected to match the pressure and flow output of the pump to be used. Secondary consideration must be given to the usual "head" requirements. Unusual circumstances or a variety of problems may alter particular needs, but crews usually speak of "high- and low-head" assignments. A representative size ejector can be found under the accessory list for each model FS pumper.

EJECTOR TESTS. If technical detail is required on equipment development tests, see EDR No. 20, "Water Ejectors for Forest Fire Fighting," USDA, FS (SDEDC), October 1953.

EJECTOR PURCHASES. Generally speaking, manufacturers produce a straight type of ejector, like the Penberthy, illustrated, or a "U" type, like the Berkeley. Since ejectors are sold commercially for a number of different jobs, the base stock item must be modified into an acceptable piece of fire gear. For example, the suction port will be equipped with a spring-type foot valve to prevent the loss of water and a strainer to prevent the entry of foreign material. The inlet and discharge ports are furnished in iron pipe threads and must be adapted to fire hose threads. A female swivel is required as an inlet connection. (For detail see modifications by Western Fire Equipment Company; catalog numbers 14X705 through 14X740.)

REPRESENTATIVE EJECTOR SELECTIONS FOR FOREST SERVICE TANKERS

Tanker Model	Pumper Model	Ejector Model	Maximum Lift*		Ejector "Pick-up" at		Ejector Return Max. Combined Flow (GPM)
			Ft.	Psi	3/4 Max. Lift (GPM)	Max. Flow (GPM)	
10	Briggs-Eco	Penberthy 62A	101	44	7	11	20
20	Berkeley B1-1/2XQBS-10	Penberthy 64A	118	51	15	28	52
	Hale or Cedco HPZZ	Penberthy 63A	122	53	10	20	36
	Edwards L-23	Penberthy 64A	127	55	16	28	53
	Pacific Pumper WA-7	Penberthy 63A	155	67	12	20	38
	Pacific Pumper WX-10	Penberthy 64A	125	54	16	28	53
	Cedco A10-F	Penberthy 62A	127	55	8	11	21
30**							
40	Gorman Rupp 02F1-GR (at 200 psi)	Penberthy 65A	127	55	23	45	85
50	Cedco HPZF	Penberthy 65A	148	64	30	45	88
	Berkeley B1-1/2XQBS-18	Penberthy 65A	152	66	31	45	88
60	Hale CBPD (at 400 psi)	Penberthy 65A	250	107	44	44	99

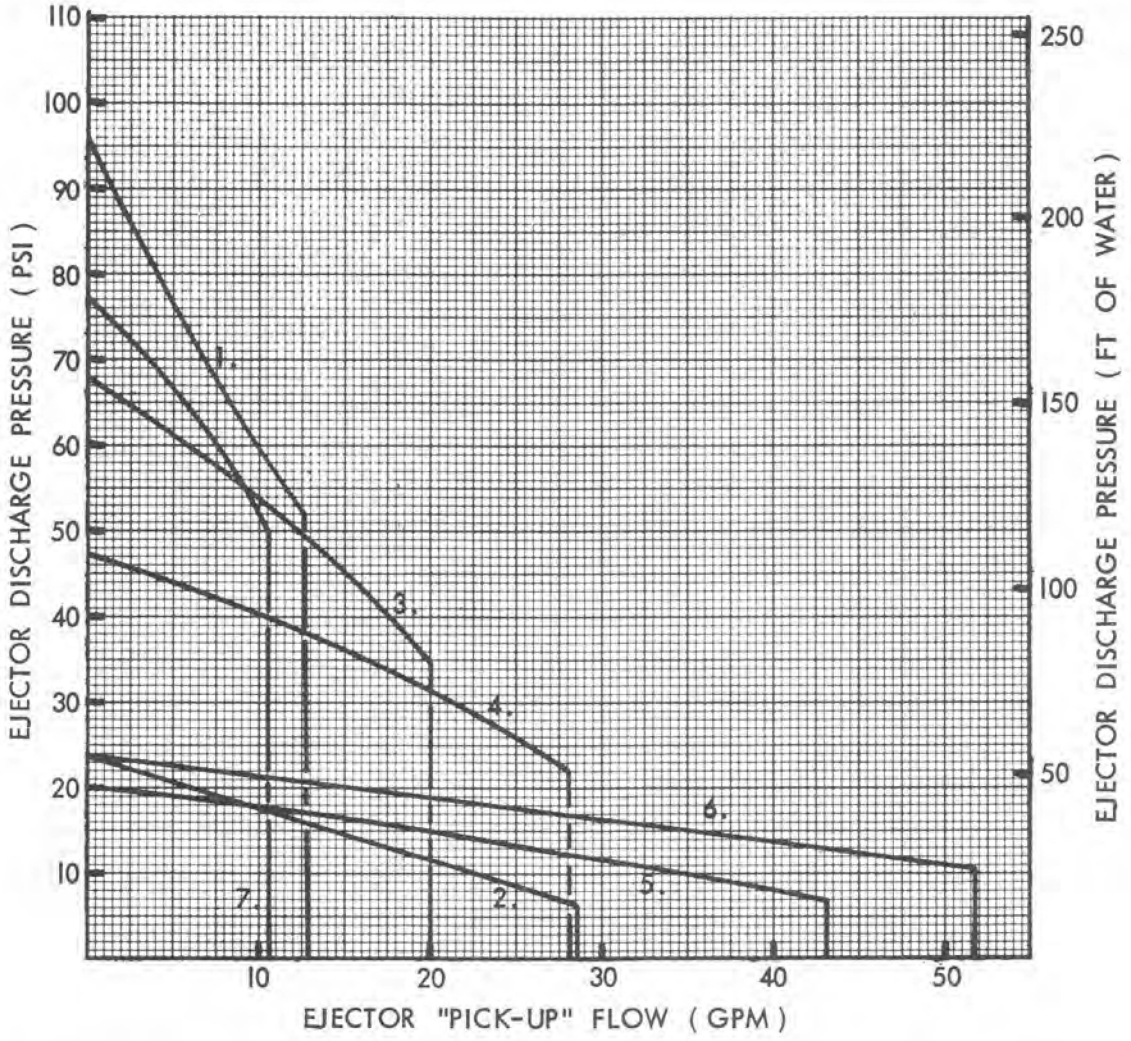
*There is no point in operating with the ejector discharge at or above the maximum lift pressure because there is no gain over the pumper flow rate (ejector "pick-up" flow is zero).

**Usually ejectors are not used with Model 30 pumpers because the pumper can be removed for drafting assignment.

SELECTION FOR COOPERATOR'S EQUIPMENT. Ejectors are selected for representative assignments by matching the ejector performance with a given pump curve. The height which a crew may wish to lift pick-up water from an ejector source back to the pumper is a very important consideration. The following set of curves shows the performance of seven different ejectors operating with a Pacific Pumper WA-7. (See graph for Ejector "Pick-up" Flow vs. Discharge Pressure for Pumper Application.)

EJECTOR PERFORMANCE

EJECTOR "PICK-UP" FLOW VS. DISCHARGE PRESSURE FOR PUMPER APPLICATIONS



PUMPER MODEL Pacific Marine WA-7

EJECTOR NO. 1 S&K Type 264 1-in.
NO. 2 S&K Type 264 1½-in.
NO. 3 Penberthy 63A
NO. 4 Penberthy 64A
NO. 5 Penberthy 65A
NO. 6 Berkeley D-17-52
NO. 7 Penberthy 62A

NOTE: IT IS ASSUMED THAT PRESSURE LOSSES IN THE SUPPLY HOSE ARE OFFSET BY STATIC PRESSURE GAINS DUE TO ELEVATION DIFFERENCES.

6.10 - INCREASERS are used to connect a male outlet end to a female inlet of a larger diameter but in the same thread standard. The male end of an increaser is always larger, since the increase is in the direction of flow, from left to right. An example: Female 1" I.P. Thread to male 1-1/2" I.P. Thread. Available in cast brass with rocker lugs. Some fire supply houses furnish increasers with different threads on each end; these are called "increaser-adapters."

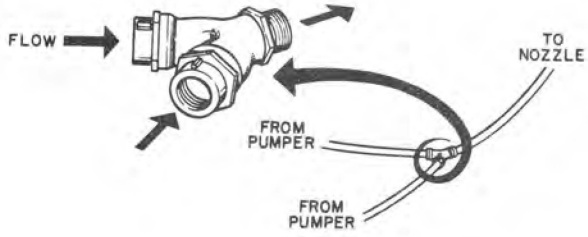
6.11 - MALE HOSE NIPPLES

connect female tapered pipe threads (N.P.T.) with female fire hose threads. The fitting is furnished with a hexagonal wrench grip in the midsection for a fixed installation on fire tankers, pipe lines, or hydrants. These nipples are also available as "reducers" or "increasers," both ends male. A more common example: 1-1/2" N.P. Thread to 1-1/2" N.S. Thread, both ends male.

Male to female and vice versa are also used.

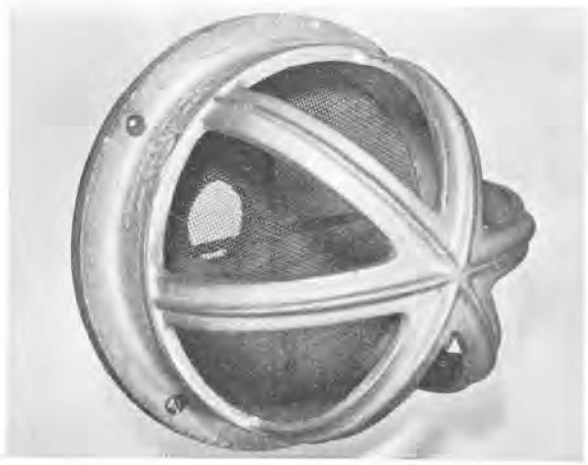
6.12 - REDUCERS connect the outlet end of any fire service to the inlet side of a smaller fitting, generally in the same thread standard. The male side of all reducers is smaller than the female, since the reduction is with the flow.

Since 1-1/2" N.S. Thread and 1" I.P. Thread are standard for FS use, this fitting need not be called a reducer-adapter. GSA carries one size, 1-1/2" to 1", FSN #4210-975-2969. FS Specification 104 requires a working pressure of 600 psi.



6.13 - SIAMESE. A siamese unites two main fire hose lines into one to increase flow. Actually, siamese connections are not used too often in FS practice. They are often confused with wyes (see section 6.22).

6.14 - GRAVITY SOCK. When water is available from a stream or spring above the fire, a gravity sock is sometimes used as a water pickup point. The sock is secured by stakes, rocks, or ropes; and the line is then run down to the fire. The canvas sock opening is usually 8" to 15" in diameter and 3' to 4' long; usually furnished in 1-1/2" threads.



6.15 - SUCTION STRAINER. Used on the submerged intake end of a portable pumper or tanker suction line. Designed to prevent debris and most abrasive material from entering the pump, where damage can easily result. FS Interim Specification 5100-00105 describes a 1-1/2" and a 2-1/2" strainer designed not to exceed 3 pounds and 5-1/4 pounds weight, respectively. Strainer body is aluminum alloy.

For 1-1/2" N.S. Thread see FSN 4210-984-3460
For 2-1/2" N.S. Thread see FSN 4210-203-3228
For 1" I.P. Thread see commercial sources.

6.16 - HOSE LINE TEE. A 1-1/2" main line connection with a 1" I.P. Thread or 3/4" G.H. Thread male outlet. A brass hose cap protects the threads on the branch outlet. Designed under FS Specification 5100-103 to withstand working pressures to 600 psi. The rigid inlet and the threaded cap are equipped with rocker lugs. Unpolished brass; weight about 23 ounces.

Also available in a 1" waterway x 1" branch outlet.

6.17 - BLEEDER VALVE. Installed in 1-1/2" hose lines to give access to the water supply for filling backpack pumps and canteens. The small water valve is operated with an open-end wrench chained to the casting. Does not interrupt the pumping operation. Unpolished brass; about 3 pounds.

6.18 - CHECK AND BLEEDER VALVE.

A combination valve used at the pumper in 1-1/2" hose lines when vertical lift is 200' or more. A swing check valve holds the water back when the pumper is stopped. Before starting the engine, the bleeder valve is opened to facilitate starting the pumper, then closed when the unit has gained sufficient head to pump against the load in the hose line. An emergency hose can be coupled to the 1" bleeder valve outlet.

The valve cap must be on top for the clapper to operate freely. Since this valve weighs around 5-1/2 pounds, it is usually placed on the ground above a short piece of hose, 3 or 4 feet from the pumper.

See FS Specification 5100-382.

6.19 - FOOT VALVE WITH STRAINER.

A combination foot valve and strainer is commonly used on the suction hose for centrifugal pumpers. These foot valves should be capable of holding a water head equivalent to 500 psi since the water in a line can flow past centrifugal pump impellers when the unit is not running. The valve should not materially reduce the pump performance. Usually available at pumper supply houses in the commonly used dimensions, 1" through 3".

Foot valves are also necessary on hydraulic ejector operations (see section 6.9).

6.20 - PRESSURE RELIEF VALVE.

Used with positive displacement portable pumpers to relieve excessive pressures, line surges, and as a water flow bypass. If all nozzles are closed, will bypass water from the main hose line by a spring-loaded release. A manually operated valve wheel adjusts the relief pressure from 50 to 250 psi, and a spoked locknut holds the adjustment. Used on 1-1/2" main hose lines at or near the pumper. Threads 1-1/2" N.S.T. x 1" I.P. or 3/4" G.H.T.

Comes in unpolished brass; weight 3 pounds. See FS Specification 5100-381.

See RELIEF VALVES FOR MODEL 10, 20, AND 30 TANKERS WITH POSITIVE DISPLACEMENT PUMPERS (section 3.0--8).

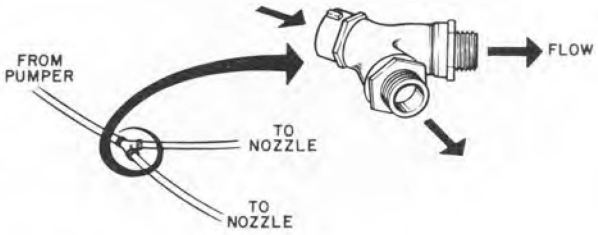
6.21 - HOSE LINE TEE VALVE.

Placed intermittently in 1-1/2" main hose lines to offer a 1" valved male branch outlet. A matching brass hose cap with rocker lugs protects the outlet threads. A female swivel connection is not provided, but a knurled section offers a handgrip. A slot in the valve wheel accepts a standard spanner.

Available in unpolished brass, 2-1/2 pounds; or in an aluminum body, 17 ounces. The lightweight tee valve is used in hose packs and in the helicopter hose tray. (For more detail see Western Fire Equipment Company catalog #14X561, aluminum.)

6.22 - GATED WYE.

Wyes are also called wye valves, wye connections, wye control valves, etc. Wye connections are often confused with siamese connections. They are not the same. A wye divides one line into two, whereas the siamese unites two lines into one. The wye is commonly used in FS practice.



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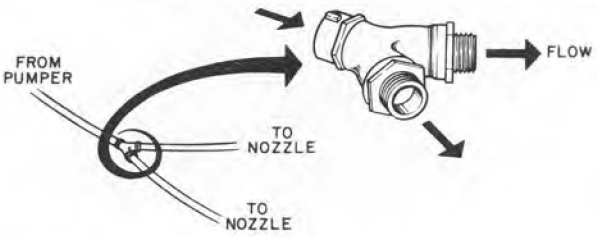


The photo shows that both male outlets are gated (with valves) to permit the control of each line independently. The 1-1/2" size is most commonly used, but 1" wyes are available. FS Specification 5100-380a requires lightweight, corrosion-resistant construction. The prequalified samples vary from 3-3/4 to 5-1/2 pounds and are capable of maintaining working pressures to 600 psi. The female swivel inlet has rocker lugs. FS wyes are tested for back pressure also. See FSN 4210-984-3475, 1-1/2" size.

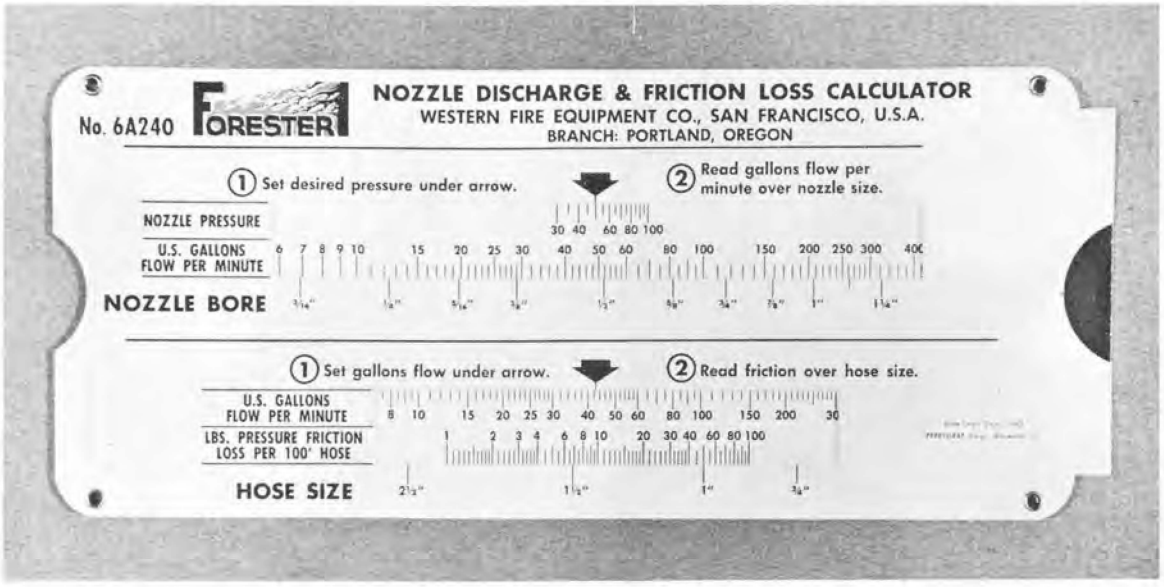
PLAIN WYES are used for a similar connection except they are without the shutoff valves. Usually ordered in 1-1/2" dimension.

ACCESSORIES AND SPECIAL ITEMS

7.0 - GENERAL. This section includes a wide range of useful equipment, training aids, and water additives for on-the-line and behind-the-line use. Since the list could be quite extensive, only the more common items and subjects have been treated.

7.1 - DISCHARGE AND FRICTION LOSS CALCULATOR. Slide rule types of calculators are available from several fire supply houses for determining flows (gpm) through commonly used nozzle bores at practical fireline nozzle pressures. These calculators also compute friction loss per 100' of hose of various diameters for a useful range of flows (gpm). They are useful for training and as guides in the selection of equipment. Components (i.e., pump, hose and nozzle) having compatible performance, size and type. They are designed for use with lined hose, not linen.

Usually these calculators contain helpful conversion factors and "rules of thumb." They are inexpensive pocket-size items, usually around 6" to 8" in length, and are provided with a protective cardboard case.


No. 6A240
FORESTER
NOZZLE DISCHARGE & FRICTION LOSS CALCULATOR
WESTERN FIRE EQUIPMENT CO., SAN FRANCISCO, U.S.A.
BRANCH: PORTLAND, OREGON
1 Set desired pressure under arrow.
2 Read gallons flow per minute over nozzle size.
NOZZLE PRESSURE
U.S. GALLONS FLOW PER MINUTE
6 7 8 9 10 15 20 25 30 40 50 60 80 100 150 200 250 300 400
30 40 60 80 100
NOZZLE BORE
1 Set gallons flow under arrow.
2 Read friction over hose size.
U.S. GALLONS FLOW PER MINUTE
8 10 15 20 25 30 40 50 60 80 100 150 200 300
LBS. PRESSURE FRICTION LOSS PER 100' HOSE
1 2 3 4 6 8 10 20 30 40 60 80 100
HOSE SIZE
2½" 1½" 1" ¾"

7.2 - FIRE HOSE SHUTOFF CLAMP.

Lightweight pocket-size shutoff clamps are available for squeezing off soft hose lines. The term "hose strangler" is also used. These clamps can be used on burst hose to extend the line, to exchange nozzles, or to insert wyes and tees. The shutoff clamp will save time, conserve water, and reduce the number of shutdowns.

The pocket-size clamps in forestry use are designed for 1" and 1-1/2" single-jacket, lined hose up to 200 to 250 psi. One manufacturer puts a hard rubber insert in each jaw to prevent hose damage. Length overall when closed, about 10"; weight, 1-1/2 pounds. See FSN 4210-767-7123.

7.3 - FOAM DESCRIPTION. Foam is a chemical fire-extinguishing mixture. Foam bubbles are formed through special equipment to greatly increase the mixture volume. It is used for filling rooms or buildings, over sumps and fuel tanks, in boxcars, and in tunnels. It may have use around FS airtanker bases. It has been used on grass, brush, and forest fires with very limited success. Wind and fireline turbulence are strong limiting factors. The vegetation tends to pierce the bubbles and increase foam breakdown. Efficient use of foam requires highly trained personnel and specialized equipment.

LIQUID FOAM concentrate is available in 5-gallon metal cans. For limited FS applications, the 6 percent mechanical protein type is suggested (Army/Navy Specification AN-JAN-C-266).

Use of foam equipment requires vehicle access. Tankers or pumpers with a general performance of 25 gpm @ 200 psi are required. Model 20 or 30 tankers with selected pumpers could meet this requirement. One-inch ID hose lines, or larger, are required.

AN IN-LINE EDUCTOR is installed in the overboard discharge line of the tanker or pumper, and the pickup end is placed in the liquid foam can. A 1" or 1-1/2" hose line is laid to the fire scene where the foam nozzle with shutoff is installed.

7.4 - SIX MAN MOPUP OUTFIT.

CONTENTS OF OUTFIT

- 6 - Hose Line Tees, 1" IPT x 1-1/2" NST
- 2 - Reducers, 1-1/2" NST x 1" IPT
- 6 - Reducers, 1" IPT x 3/4" GHT
- 6 - Applicators, 48" x 3/4" GHT
- 6 - Fog Tips for Applicators, 3 gpm
- 2 - Fog Tips for Applicators, 15 gpm
- 2 - SS Tips for Applicators, 1/4" bore
- 6 - Shutoff Valves, Ball Valve, 3/4" GHT
- 6 - Wyes, 3/4" x 3/4" x 3/4" GHT
- 6 - Spanners, 3/4" - 1-1/2"
- 20 - Gaskets, Assorted
- 2 - Knapsacks, Canvas
- 6 - Pouches, With Belt Loops
- 1 - Box, 7" x 9-1/2" x 50"

Designed for the Pacific Northwest Region (R-6) of the Forest Service for use in deep ground litter and duff where extensive mopup is required. A six-man mopup crew can effectively cover a wide area of fireline with water from a small diameter hose line off a 1-1/2" main lay. The outfit is composed of small hose connections, water applicators with fog and straight-stream tips, and shutoff valves. See Western Fire Equipment Company catalog No. 14X810.

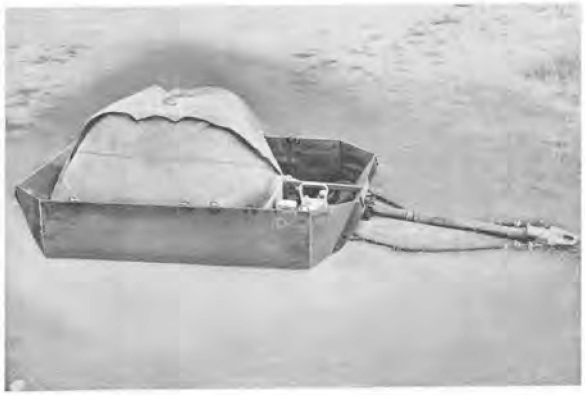
This outfit should be supplemented with portable pumpers or tankers of 30 to 50 gpm performance at reasonably high pressures. Fire hose requirements would include 1-1/2" and 1" hose for the main lay and branch lines, with at least 500' to 1,000' of garden hose for use with the six-man mopup outfit.

7.5 - FIRE HOSE ROLLER.

A time-saving device designed and used by the California Division of Forestry to handle 50- or 100-foot lengths of 1" or 1-1/2" lined or linen hose in either single or double rolls. A supporting bracket allows vertical mounting on a post, wall, or tanker panel. Extra supporting brackets may be hung on various wall faces and trucks in work areas. A rocker lug nut secures the hose roller. Parts are commercially available. (See Western Fire Equipment catalog No. 14X800.)

7.6 - COLLAPSIBLE AND FOLDING LIQUID STORAGE TANKS.

The tanks covered by FS Interim Specification 5100-00345 are for storing and transporting non-potable water used in fire suppression and prescribed burn work. They may also be used for transporting and dispensing water, gasoline, diesel fuel, herbicides and insecticides.



Two types are proved under the specification and both are available from GSA:

Type I - Pillow-shaped design, as shown in the staging pod illustration

Type II - Selfsupporting or pyramidal-shaped as shown in the photograph.

Type I (Pillow-shape)

Gals.	FSN
50	5430-935-5723
100	5430-935-5724
150	5430-935-5725

Type II (Pyramidal-shape)

250	5430-935-5726
500	5430-935-5727

TANKS WITH TUBULAR FRAMES.

Large square canvas tanks which are laced to light-weight tubular metal frames are also available. These 600-, 1,000-, and 1,500-gallon tanks are open at the top and serve as ready water supplies or for fire retardant storage. Helicopters can dump into or pick up liquid loads from these tanks. They can be folded into small, compact, rectangular packages for convenient storage or air transport.

7.7 - FIRE HOSE WASHER. Designed to clean all types of hose up to and including 1-1/2" in diameter. There are no critical adjustments for flow or pressure. Should be used with an adequate supply of water from a high-performance portable pumper to support the multiple jet action on the inside of the washer. Hose is drawn back and forth through the washer cylinder until clean. Overall dimensions, 5-1/2" wide x 12" long x 6" high; weight, 10 pounds (see Pacific Pumper catalog No. C-2729).

7.8 - WETTING AGENT. NFPA defines a wetting agent as "a chemical additive used to modify the characteristics of water used for fire fighting. It reduces surface tension, permitting better dispersal and greater penetration . . . ."

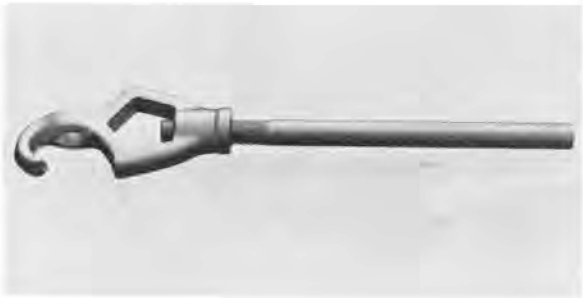
Wet water is helpful where penetration is needed in duff, in deep litter, in the peat bogs in the South, and through muskeg and tundra in Alaska. Under the retardant evaluation program of the FS, the Southern Forest Fire Laboratory, Macon, Georgia, is responsible for testing surface tension, solubility, foamibility, foam breakdown rate, and wetting action. Toxicity and corrosion information is supplied by the manufacturers.

The test results are sent through the Division of Fire Control, Washington, D.C., to the National Forests in the form of an "acceptable List of Wetting Agents." Liquid wetting agents are distributed in various sizes of containers, from back-pack pump proportions, to 50-gallon drums.

Wetting agents disperse quickly and easily in water, and no specialized equipment is required. Tanks, pumps, hose, and accessories should be flushed out after use. Wet water should not be held for long periods in FS fire tankers having metal tanks.

7.9 - HYDRANT AND SPANNER WRENCHES.

HYDRANT WRENCH. For use on pentagon (five-sided) hydrant stems of the four most common sizes: 1-3/4", 1-1/4", 1", and 3/4". The handle forms a pin lug spanner which is non-standard for FS use. Weight, 20 ounces. Available from most fire supply houses.



ADJUSTABLE HYDRANT WRENCH AND UNIVERSAL SPANNER. For use on any size pentagon hydrant stem up to 1-3/4". Threaded handle adjusts to make a positive 3-point clamp even on damaged or rounded nuts. Terminal thread is swaged to prevent loss of handle. Rocker and pin lug spanner is incorporated in the head design. Malleable iron or steel.

Length 15" to 20"; weight, 4-1/2 pounds. (See NFPA Std. No. 19, 1965.)

SPANNER WRENCH, 1" to 1-1/2".

A rocker lug spanner used to break or tighten fire hose connections. This small 6-inch spanner is used on 3/4", 1", and 1-1/2" connections. Bronze construction; weighs 7 ounces. To FS Specification 5100-101. See FSN 5120-596-1426.

LIGHTWEIGHT SPANNER WRENCH, 1" to 1-1/2". Designed as a 2-1/2 ounce universal spanner for pin or rocker lugs from 3/4" to 1-1/2". Length 5-3/4"; made of Tenzaloy (see Western Fire Catalog No. 2A910).

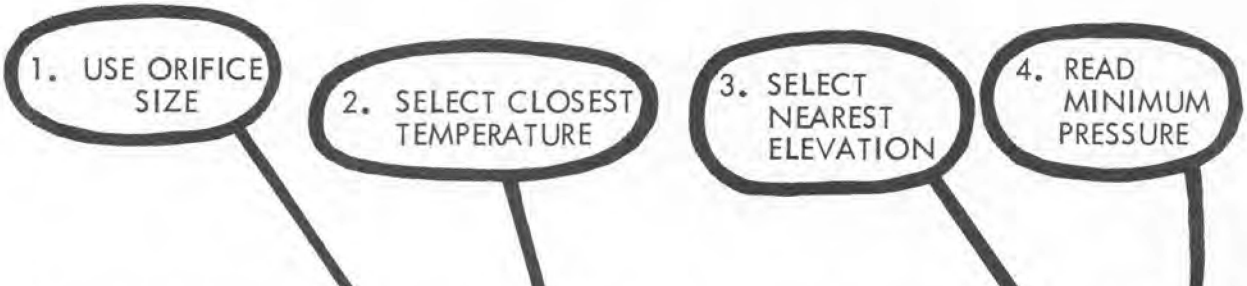
COMBINATION SPANNER WRENCH, 1" to 2-1/2". For slotted or rocker lug FS couplings or fittings. Length, 8-3/4". See FS Specification 5100-101. See FSN 5120-596-1427.

TEST EQUIPMENT

8.0 - STANDARD TESTS. Pumps require careful checking, fire hose must be tested, and nozzles and accessories should be carefully maintained if an acceptable job is to be done with water handling equipment on fires. Certain test equipment is required to maintain FS standards.

8.1 - PUMPER PERFORMANCE AND MAINTENANCE STANDARDS KIT. A test kit has been designed and minimum performance standards for maintenance have been established for most of the pumpers in FS use. These maintenance standards are arranged as convenient tables which indicate the minimum psi reading which is acceptable using one of five orifice plates after correcting for temperature and elevation.

EXAMPLE. An example is included for a Hale HPZZ pumper at an approximate temperature of 80° F and an elevation near 3,700'. By inserting the 15/64" orifice size plate and reading on the 85° F temperature line in the 4,000' elevation column, we see the HPZZ should produce 182 psi, or more.



PUMPER	Orifice Size	Temp. °F	Sea Level Elevation		1,000 Elevation		4,000 Ft. Elevation		5,000 Elevation
			PSI	GPM	PSI	M	PSI	GPM	PSI
HALE HPZZ 23FB-B&S Engine	15/64"	55	209	14.1	20	.6	190	13.[illegible]	185
		[illegible]	205	13.9	20	3.5	186	[illegible].3	181
		85	201	13.8	19	3.3	182	13.2	17[illegible]
		[illegible]	197	13.7	19	3.2	[illegible]	13.0	17
HALE CBP 264 cu. in. Engine	3/4"	55	328	188	3[illegible]	182	299	180	
		70	322	186	[illegible]	180	293	178	
		85	316	185		178	287	176	
		100	310	183	3	177	281	174	

Technical Equipment Report No. 5100-12, PUMPER PERFORMANCE MAINTENANCE STANDARDS, November 1960, is available from the Division of Fire Control, Washington, D.C., or from SDEDC.

ORIFICE TEST KIT. The kit was designed by SDEDC for use by a qualified mechanic for annual overhaul surveys and troubleshooting. It serves as a practical device for checking pumper trouble on the fireline, or determining acceptable psi and gpm performance on the new pumps.

The kit includes a meter tube, an accurate pressure gauge and hose, five orifice plates (1/8", 11/32", 15/64", 31/64", and 3/4") and a wooden case. A blank plate is also included for testing pumper gauge accuracy.

Carefully machined orifice plates give reliable performance readings while nozzles may vary up to 30 percent.

(For further detail see Western Fire Equipment Company catalog number 5A020.)

8.2 - PIEZOMETER. Piezometers are kits provided for fire department use. A simpler form known as a line gauge is shown. This has FS application for determining exact hydrant or nozzle pressures on static or flowing lines. Usually available in 1", 1-1/2", and 2-1/2" diameters weighing about three pounds. Overall length runs 5" to 6".

A 0-200 pound gauge is usually furnished; however, a 0-300 pound gauge is recommended.

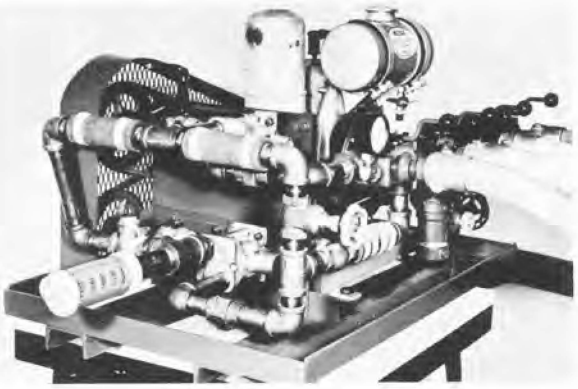
8.3 - ONE-LINE MANUAL FIRE HOSE TEST PUMP. Also called hydrostatic test pump or fire hose tester. These single-line pump assemblies include a pressure cylinder with ball check-valves, a metal arm for manual pumping, and an accurate test gauge with a maximum indicator needle.

The basic connections are often 2-1/2" N.S. Thread, but reducers and increasers are available for FS hose diameters. Attachments are also available for testing fire extinguishers.

These test pumps vary in their working pressure capability but are usually furnished between 600 and 800 psi. The water source can be from a garden hose hydrant. They are for use with lined hose; not linen.

8.4 - FOUR-LINE POWER DRIVEN FIRE HOSE TESTER.

This 4-line tester (pump) is designed to handle large fire hose reconditioning assignments. The high-pressure, low volume pump can be driven by either an electric motor or an air-cooled gasoline engine. The pump is designed to operate in parallel for quick filling and then in series to build up to the required test pressure.



Ordinarily equipped with a 1" suction connection with four 1-1/2" fire hose connections. Four 1-1/2" blanking caps with bleeder valves provide for a safe testing job.

Overall approximate dimensions: 15" high x 23" wide x 30" long. Weight around 250 pounds (see Pacific Pumper catalog number FA-151).

For operational details of fire hose testing see NFPA Pocket Edition 198, CARE OF FIRE HOSE.

BACKPACK PUMPS

9.0 - GENERAL. In many areas of the United States the backpack pump is a primary fireline tool in the equipment cache. The majority of these are hand-operated but limited use has been made of a few engine-driven units, largely on an evaluation basis.

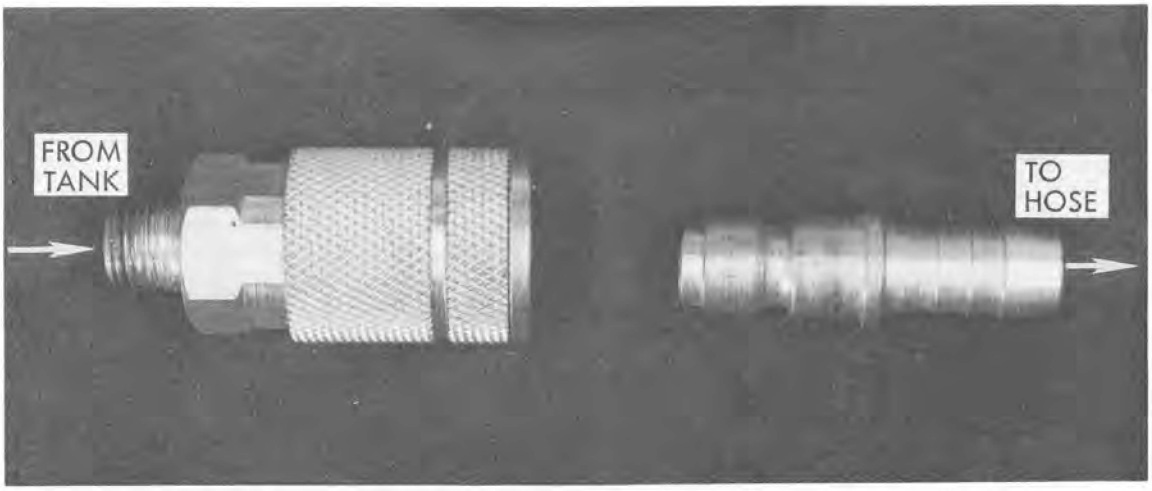
9.1 - HAND-OPERATED. In 1972 the following Forest Service specifications were adopted:

5100-00256 Tank, Fire, Backpack.
5100-00257 Pump, Fire, Backpack, Hand-operated.

These are performance specifications, for the most part, and contain only a few essential requirements. This permits flexibility in design and construction by various manufacturers which will still meet field needs. The slide fire pump is designed to pump water from a backpack tank onto grass, brush, and wood fires. The tank may be one of various rigid patterns, or it may be collapsible. All tanks must have carrying straps, a filler cap, and a standard quick-connect hose fitting. The tank is designed to have at least a three-year service life.

9.1.1 - PUMP. Pumps are grouped as single-acting (Type I) and double-acting (Type II). The type desired should be specified. Pump design allows easy disassembly and assembly without special tools. The dry weight of the pump with the nozzle and without hose cannot exceed 2 lbs, 8 oz. The 3/8-in. hose cannot weigh more than 12 oz. The overall length of the pump when contracted cannot exceed 20 in., including the nozzle. The outside diameter of the cylinder cannot be more than $1\frac{1}{2}$-in. The pump has a lock or drag feature to hold the pump in a contracted position when carried, but this feature must not restrict the operation. Hand grips are required at the forward and rear end for the safety and comfort of the operator.

A hose fitting barb must be installed on the pump. The outside of the hose barb is for 3/8-in. ID hose. The 4-ft section of hose is designed to push onto the barb by hand and will withstand a 50-lb pull without separating. A clamp may be used but is not required.



The free end of the hose is fitted with a quick-connect coupling nipple to mate with the coupler section on the tank. Both the hose barb and the quick-connect nipple have clear open waterways of at least 1/4-in.

The nozzle is equipped with 1/4-18 NPSM free-fitting American Standard straight-pipe internal threads.

The nozzle is designed to satisfy the performance requirements stated but must not weigh more than 3-oz. Twin-tip nozzles may be used but must be attached by a chain.

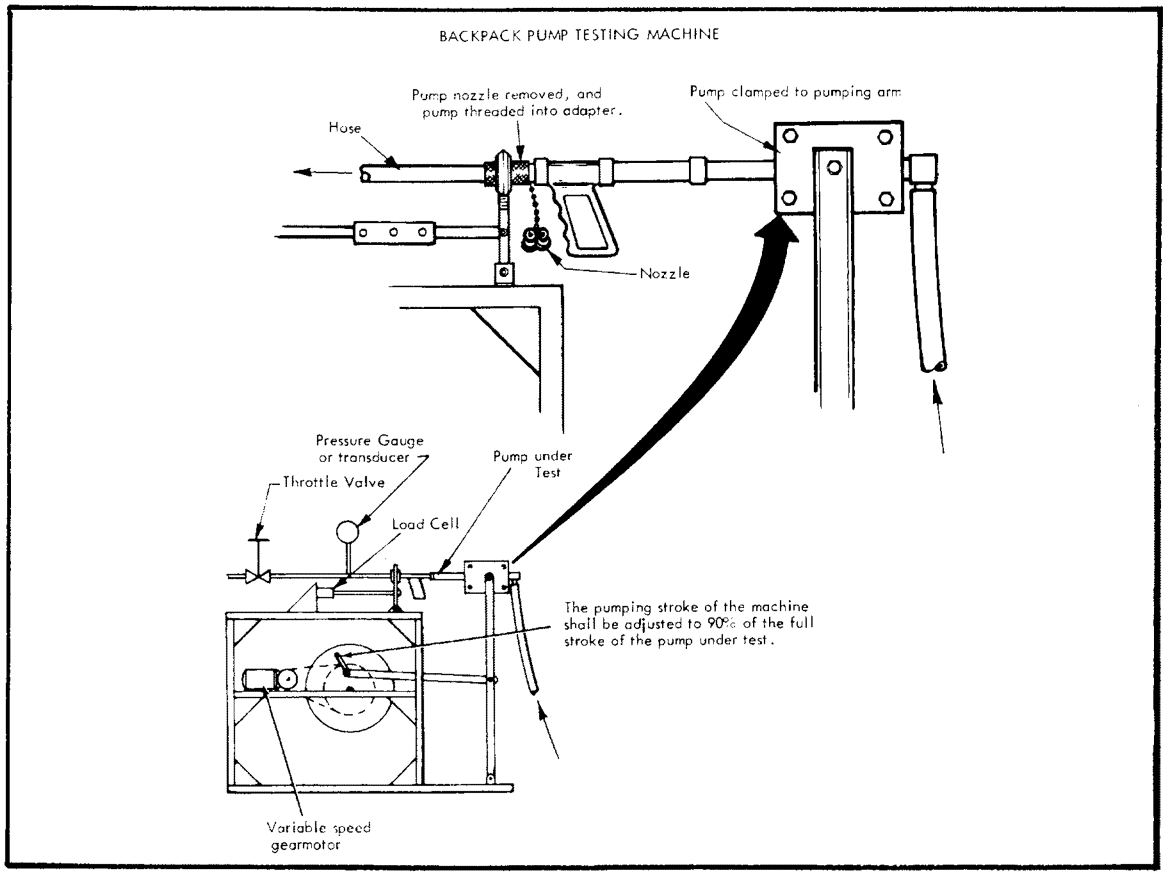
The nozzle must be capable of producing a solid stream and a 30° cone or fan spray. The solid-stream nozzle, when coupled to a 35 psi water source, must be capable of projecting a solid stream of water vertically to a height of at least 17 ft above the end of the nozzle, and deliver not less than 0.75 gallons nor more than 1.25 gallons of water per minute. The spray nozzle, when coupled to a 35 psi water source, must deliver not less than 0.75 gallons nor more than 1.25 gallons of water per minute.

In addition to the requirements given, tests are conducted at San Dimas on pumps submitted for the following:

- Flow Rate and Force - The pump, without nozzle, must deliver at least 0.75 gpm @ 35 psig after completion of 50,000 cycles of operation. The maximum force required to attain this condition cannot exceed 25 lbs. The test apparatus shown is adjusted to pump at 30 cycles per minute for the test.

- Maximum Pumping Rate Test - The pump will be used without the nozzle to establish the maximum pumping rate test. The rate will be adjusted to various incremental rates through at least 70 cycles per minute. The resulting flow rate curve must be linear to at least 45 cycles per minute pumping rate.

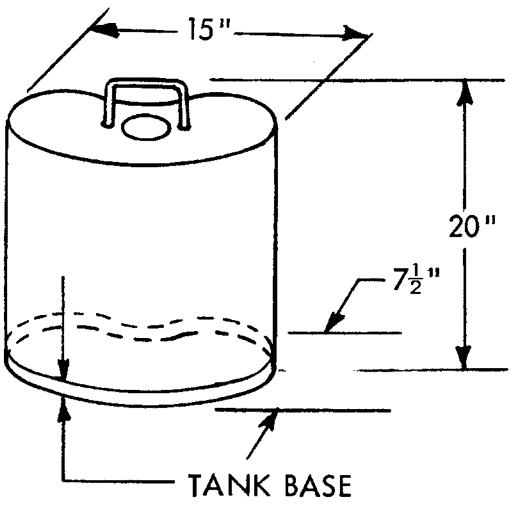
- Static Pumping Force - The pump supplied will be capable of withstanding a static pumping force of 100 lbs for 5 seconds without damage.


BACKPACK PUMP TESTING MACHINE
Pump nozzle removed, and pump threaded into adapter.
Pump clamped to pumping arm
Hose
Nozzle
Pressure Gauge or transducer
Throttle Valve
Load Cell
Pump under Test
The pumping stroke of the machine shall be adjusted to 90% of the full stroke of the pump under test.
Variable speed gearmotor

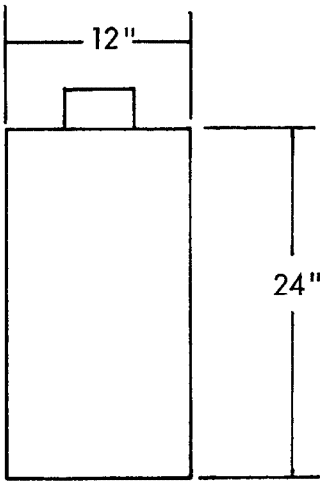
9.1.2 - TANK. Orders must specify the following options established by the specification:

The general shape categories are as follows:

Type I
(Form-fitted)



Type II
(Collapsible)



Dimensions will not exceed those indicated above. Maximum weight of Type I tanks is 9 lbs; for Type II tanks, 3 lbs.

The tank body materials are one of the following:

Class A - Galvanized Steel

Class B - Stainless Steel

Class C - Plastic

Class D - Coated Fabric (Type II only)

Corrosive wetting agents should not be used in Class A tanks. Tank sizes are categorized as follows:

Size 4 - 3.9 to 4.3 U.S. Gallons

Size 5 - 4.9 to 5.5 U.S. Gallons

Company design provides for complete interchangeability of replacement parts with the units of the same manufacturer's model.

The filler neck of Type I tanks have a minimum waterway of $3\frac{1}{2}$-in.; Type II 1-7/8-in.

The water outlet of the tank is provided through a 3/8-in. size quick-connect coupler. The outlet has a minimum waterway of at least 1/4-in. With the mating nipple disconnected, the coupler completely shuts off the water flow from the tank.

The quick-connect coupler is equivalent and fully interchangeable with the following identified products:

Amflow Series T. Industrial Couplers 3/8-in. size size waterways Coupler with 3/8-in. NPT (TK 03) Male Plug Section with hose barb	Amflo Industrial Products Amflo Products, Inc. 1930 South Anaheim Blvd. Anaheim, California 92805
Fowler-Pem Coupler, end (TK 23) 3/8-in. size, 3/8-in. NPT (X-1 or X-2)	Fowler Pem Co. 5924 Fremont Street Riverside, California 92502
Tru-Flate Series 10 Coupler 3/8-in. Body Size, 3/8-in. NPT (B14N or B15N)	Quick-Coupling Division Parker-Hannifin 8145 Lewis Road Minneapolis, Minnesota 55427

A suitable carrying handle or bail is provided on top of all qualified tank.

A set of two carrying straps are provided for each tank. The webbing straps are at least 1½-in. wide and are equipped with necessary hardware and provide for size adjustments. A swivel snap or other suitable fastener provides for stowage for the slide pump.

9.1.3 - NOTICE OF QUALIFICATION. If the documents and the pumps and/or tanks comply with all requirements of the two specifications, a notice of qualification is issued to the manufacturer in writing by the Director, Equipment Development Center, San Dimas.

9.1.4 - QUALIFIED PRODUCTS LIST. A qualified products list (QPL) will be maintained in this section of the Water Handling Equipment Guide for procurement purposes. The following categories will be included:

Tank	Pump	
	Type	Action
Shape: Type I or II	I	Single acting
Material: Class A, B, C, or D	II	Double acting
Size: 4 or 5		

9.1.4 - QUALIFIED PRODUCTS LIST CONTINUED.

Backpack Tank (See FS Specification 5100-00256)

Type I, Size 4 or 5, Class A, B, C, or D	No qualifications to date.
Type II, Size 4 or 5, Class A, B, C, or D	No qualifications to date

Backpack Pump (See FS Specification 5100-00257)

Type I, (Single Acting)	No qualifications to date.
Type II, (Double Acting)	No qualifications to date.

APPENDIX

(For optional use)

EQUIVALENTS (RULES OF THUMB)

Volumes (Capacity)

1 U.S. gal.	=	4 qts.
	=	128 fluid ounces
	=	231.0 cu. in.
	=	0.1337 cu. ft.
1 Barrel (U.S. liquid)	=	31.5 gal.
1 Barrel (petroleum)	=	42.0 gal.
1 cu. ft.	=	7.481 gal.
	=	1,728 cu. in.
1 Hose Length, 1½" ID x 100	=	9 gal. (approximate)
1" ID x 100	=	4 gal. (approximate)

Weight

1 ft. of Water Head (Column of Water)	=	½ psi (0.434 psi)
1 U.S. gal.	=	8 lbs (8.335)
1 cu. ft. of Water	=	62.4 lbs
1 Crewman's Weight (Average for design purposes)	=	175 lbs

Pressure

1 lb per sq. in.	=	2 ft. of Water Head (2.304 ft.)
Normal Atmospheric Pressure	=	14.696 psi at sea level; or 29.92 in. of mercury at 32°F
1000 ft. increase in ground	=	½ lb decrease in atmospheric pressure

Draft

1 in. of Mercury	=	1 ft. of lift (1.134 ft)
Drafting Guidelines:		
Theoretical lift (Max.)	=	33.9 ft. lift
Attainable	=	29.4 ft. lift
Excellent pump	=	28 ft. lift
Good pump	=	26 ft. lift

DISCHARGE OF NOZZLES IN GALLONS PER MINUTE

Head		Velocity of Disch. Ft. per Sec.	Diameter of Nozzle in Inches					
Lbs.	Ft.		1/8	3/16	1/4	3/8	1/2	1
10	23.1	38.6	1.48	3.32	5.91	13.3	23.6	94.5
15	34.6	47.25	1.81	4.06	7.24	16.3	28.9	116.
20	46.2	54.55	2.09	4.69	8.35	18.8	33.4	134.
25	57.7	61.0	2.34	5.25	9.34	21.0	37.3	149.
30	69.3	66.85	2.56	5.75	10.2	23.0	40.9	164.
35	80.8	72.2	2.77	6.21	11.1	24.8	44.2	177.
40	92.4	77.2	2.96	6.64	11.8	26.6	47.3	189.
45	103.9	81.8	3.13	7.03	12.5	28.2	40.1	200.
50	115.5	86.25	3.30	7.41	13.2	29.7	52.8	211.
55	127.0	90.4	3.46	7.77	13.8	31.1	55.3	221.
60	138.6	94.5	3.62	8.12	14.5	32.5	57.8	231.
65	150.1	98.3	3.77	8.45	15.1	33.8	60.2	241.
70	161.7	102.1	3.91	8.78	15.7	35.2	62.5	250.
75	173.2	105.7	4.05	9.08	16.2	36.4	64.7	259.
80	184.8	109.1	4.18	9.39	16.7	37.6	66.8	267.
85	196.3	112.5	4.31	9.67	17.3	38.8	68.9	276.
90	207.9	115.8	4.43	9.95	17.7	39.9	70.8	284.
95	219.4	119.0	4.56	10.2	18.2	41.0	72.8	292.
100	230.9	122.0	4.67	10.5	18.7	42.1	74.7	299.
105	242.4	125.0	4.79	10.8	19.2	43.1	76.5	306.
110	254.0	128.0	4.90	11.0	19.6	44.1	78.4	314.
115	265.5	130.9	5.01	11.2	20.0	45.1	80.1	320.
120	277.1	133.7	5.12	11.5	20.5	46.0	81.8	327.
125	288.6	136.4	5.22	11.7	20.9	47.0	83.5	334.
130	300.2	139.1	5.33	12.0	21.3	48.0	85.2	341.
135	311.7	141.8	5.43	12.2	21.7	48.9	86.7	347.
140	323.3	144.3	5.53	12.4	22.1	49.8	88.4	354.
145	334.8	146.9	5.62	12.6	22.5	50.6	89.9	360.
150	346.4	149.5	5.72	12.9	22.9	51.5	91.5	366.
175	404.1	161.4	6.18	13.9	24.7	55.6	98.8	395.
200	461.9	172.6	6.61	14.8	26.4	59.5	06.	423.
250	577.4	193.0	7.39	16.6	29.6	66.5	118.	473.
300	692.8	211.2	8.08	18.2	32.4	72.8	129.	517.

PUMP PRESSURES FOR 50 LBS NOZZLE PRESSURE

1-in. Hose

Length Hose in ft.	Nozzle above Pump in ft.	Tip Sizes 1/8	3/16	1/4	5/16	3/8
100	0	51	52	55	62	75
	100	94	95	98	105	118
200	0	51	54	60	74	98
	100	94	97	103	117	141
300	0	52	56	65	86	121
	100	95	99	108	129	164
	200	139	143	152	173	208
400	0	52	58	70	98	144
	100	95	101	113	141	187
	200	139	147	157	185	231
	300	182	190	200	228	274
500	0	53	60	75	110	167
	100	96	103	118	153	210
	200	140	147	205	197	254
	300	183	190	292	240	297
1000	0	56	70	110	170	282
	100	99	113	153	213	325
	200	143	157	197	257	369
	300	186	200	240	300	
	400	229	243	283	343	
	500	273	287	327	387	
	600	316	330	370		
DISCHARGE (GPM)		3	7	12	19	28

These 50 lb. Nozzle Pressure tables have been reprinted from the "Tankers and Equipment" catalog, R-5, USDA - Forest Service (out of print). The final computed values will vary slightly from the 100 lb. tables because of factor differences for discharge and friction loss.

PUMP PRESSURES FOR 50 LBS NOZZLE PRESSURE

$1\frac{1}{2}$-in. Hose

Length Hose in ft.	Nozzle above Pump in ft.	Tip Sizes 1/8	3/16	1/4	5/16	3/8
100	0	51	51	51	52	53
	100	94	94	94	95	96
200	0	51	52	52	54	56
	100	94	95	95	97	99
300	0	51	52	53	56	60
	100	94	95	96	99	103
	200	138	139	140	143	147
400	0	51	53	54	58	63
	100	94	96	97	101	106
	200	138	140	141	145	150
	300	181	183	184	188	193
500	0	51	53	55	60	66
	100	94	96	98	103	109
	200	138	140	142	147	153
	300	181	183	185	190	196
1000	0	51	55	59	68	82
	100	94	98	102	111	125
	200	138	142	146	155	169
	300	181	185	189	198	212
	400	224	228	232	241	255
	500	268	272	276	285	299
	600	311	315	319	328	342
2000	0	52	59	67	84	114
	100	95	102	111	127	157
	200	139	146	155	171	201
	300	182	189	198	214	244
	400	225	232	241	257	287
	500	269	276	285	301	331
	600	312	319	328	344	374
	700	355	362	371	387	
	800	298	405			
3000	0	53	64	75	100	146
	100	96	107	118	143	189
	200	140	151	162	187	233
	300	183	194	205	230	276
	400	226	237	248	273	319
	500	270	281	292	317	363
	600	313	324	335	360	
	700	356	367	378	403	
DISCHARGE (GPM)		3	7	12	19	28

PUMP PRESSURES FOR 100 LBS NOZZLE PRESSURE

3/4-in. Hose (High pressure)

Length Hose in ft.	Nozzle above Pump in ft.	Tip Size 1/8	3/16	1/4	5/16	3/8
100	0	103	113	138	183	253
	100	146	156	181	226	296
150	0	105	120	157	224	327
	100	148	163	200	267	362
200	0	106	126	176	266	406
	100	149	169	219	309	449
250	0	108	132	195	307	482
	100	151	173	238	350	325
300	0	110	139	214	349	559
	100	153	182	257	392	602
	200	197	226	301	436	646
400	0	113	152	252	432	712
	100	156	195	295	475	755
	200	200	239	339	519	799
	300	243	282	382	562	842
500	0	116	165	290	515	
	100	159	208	333	558	
	200	203	252	377	602	
	300	246	295	420	645	
DISCHARGE (GPM)		4.7	10.5	18.7	28.7	42.1
PSI LOSS/100 FT		3.3	13.0	38	83	153

Shaded areas indicate hose pressures near the tanker which exceed the normal working pressure of FS Specification 5100-185 High Pressure Hose.

Computations assume that all hose is pulled off the reel in a straight lay. If a significant amount of hose is left on the reel the friction loss will be increased (see chart in section 4.4).

PUMP PRESSURES FOR 100 LBS NOZZLE PRESSURE

1-in. Hose

Length Hose in ft.	Nozzle above Pump in ft.	Tip Sizes 1/8	3/16	1/4	5/16	3/8	1/2
100	0	101	103	109	118	135	200
	100	144	146	152	161	178	243
200	0	101	106	118	136	170	300
	100	144	149	161	179	213	343
300	0	102	109	127	154	205	400
	100	145	152	170	197	248	443
	200	189	196	214	241	292	487
400	0	103	112	136	172	240	500
	100	146	155	179	215	283	543
	200	190	199	223	259	327	587
	300	233	242	266	302	370	630
500	0	103	115	145	190	275	600
	100	146	158	188	233	318	643
	200	190	202	232	277	362	687
	300	233	245	275	320	405	730
1000	0	107	131	190	280	450	
	100	150	174	233	323	493	
	200	194	218	277	367	537	
	300	237	261	320	410	580	
	400	281	305	364	454	624	
	500	324	348	407	497	667	
	600	368	392	451	541	711	
DISCHARGE (GPM)		4.7	10.5	18.7	28.7	42.1	74.7
PSI LOSS/100 FT		0.7	3.1	9.0	18.0	35	100

Shaded areas indicate hose pressures near the tanker which exceed the normal working pressure of FS Specification 5100-00186 Single jacket, cotton-synthetic lined hose.

PUMP PRESSURES FOR 100 LBS NOZZLE PRESSURE

1½-in. Hose

Length Hose in ft.	Nozzle above Pump in ft.	Tip Sizes 1/8	3/16	1/4	5/16	3/8	1/2
100	0	101	101	102	103	106	117
	100	144	144	145	146	149	160
200	0	101	102	103	107	112	134
	100	144	145	146	150	155	177
300	0	101	103	105	110	118	151
	100	144	144	148	153	161	194
	200	188	190	192	197	205	238
400	0	101	102	106	113	124	168
	100	144	145	149	156	167	211
	200	188	189	193	200	211	255
	300	231	232	236	243	254	298
500	0	101	103	108	117	130	185
	100	144	146	151	160	173	228
	200	188	190	195	204	217	272
	300	231	233	238	247	260	315
1000	0	101	105	115	133	160	270
	100	144	148	158	176	203	313
	200	188	192	202	220	247	357
	300	231	235	245	263	290	400
	400	275	275	289	307	334	444
	500	318	322	332	350	317	487
	600	362	366	376	394	421	531
2000	0	102	110	130	166	220	410
	100	145	153	173	209	263	433
	200	189	197	217	253	307	527
	300	232	240	260	296	350	570
	400	276	284	304	340	394	614
	500	319	327	347	383	437	657
	600	363	371	391	427	481	701
	700	406	414	434	470	524	744
	800	450	458	478	514	568	788
3000	0	103	115	145	199	280	610
	100	143	158	188	242	323	653
	200	190	202	232	286	367	697
	300	233	245	275	329	410	740
	400	277	289	319	373	454	784
	500	320	332	362	416	497	827
	600	364	376	406	460	541	871
	700	407	419	449	503	584	
	800	451	463	493	547	628	
DISCHARGE (GPM)		4.7	10.5	18.7	28.7	42.1	74.7
PSI LOSS/100 FT		0.1	0.5	1.5	3.3	6.0	17

Shaded areas indicate hose pressures near the tanker which exceed the normal working pressure of FS Specification 5100-00186 Single jacket, cotton-synthetic lined hose.

Cleveland N.F. Dec

5162

FOREST SERVICE GUIDE
WATER HANDLING EQUIPMENT GUIDE
SAN FRANCISCO, CALIFORNIA

DECEMBER 1972

TITLE 5162 - FIRE CONTROL
REGION 5 SUPPLEMENT NO. 2

Superseded Pages	New Pages
None	10 (2.0--3 thru --4)

Digest:

Condenses information, guidelines, and policy of use for "Sirens and Red Warning Lights" to meet State Laws and Federal Regulations on Forest Service Vehicles.

Remarks:

Place the new material in the appendix section of the WATER HANDLING EQUIPMENT GUIDE. Also suggest placing this letter of transmittal in the back of the GUIDE.

DOUGLAS R. LEISZ
Regional Forester

CLEVELAND N. F.
__PIO (DATE AND
__SUPV INITIAL)
__AO
__LANDS
__ENG
__RES
__REC & USES
__AFCO
__DISP
__FRECONST ENG
__CONST ENG
__L. A.
__B & F
__ADM SVCS
__PMS
__RES ASST
__RES CLK
__TYPING
__RCVD
__DR

FEB 21 1973

SIRENS and RED WARNING LIGHTS

10 (2.0) - GENERAL. The Regional (R-5) Standard as recommended by the Regional Fire Equipment Committee consists of:

2 - Forward facing, steady burning red lights
1 - Oscillating red light mounted on a speaker base
1 - Amber flashing light facing the rear
1 - Electronic siren control with microphone
1 - Dash panel with switches for lights and siren horn control

On large fire trucks, an additional steady red light is to be placed on the front grill and one on the rear tailboard.

Sirens and red warning lamps shall be installed only on authorized emergency vehicles. The Forest Supervisor shall have the authority to designate those vehicles authorized for siren and red light installations.

All new installations of sirens and red lights shall be in accordance with the Region Five Standard regardless of vehicle age or when installation is made. Present devices and/or installations may remain in service until the vehicle on which they are mounted is replaced or the devices are removed.

INSTRUCTIONS, OPTIONS AND FINANCING

(1) Model 60 Fire Tankers (Class I) - WCF financing. All units will have installations made and shall remain on the unit regardless of location.

(2) Model 51 Fire Tankers (Class II) - WCF financing. All units will have installations made and shall remain on the unit regardless of location.

(3) Model 40 PTO Fire Tanker (Class III) - WCF financing. Installation is a Forest option.

(4) Crew hauling vehicles (Hotshot trucks, Buses) shall not have red light and siren installations.

(5) All other vehicles are a Forest option and will be at Project expense. Those devices installed at Project expense will not be capitalized per FSH 6509.11, Section 22.2.

INSTALLATION PROCEDURES AND ARRANGEMENT

Installation procedures and arrangement of devices, as well as the devices being used, are in accordance with the California Motor Vehicle Code, Code of Federal Regulations -- Title 49: Transportation; California Administrative Code -- Title 13: Motor Vehicles; and the California Highway Patrol Approved Devices Handbook.

WRITTEN MATERIALS. Detailed drawings, specifications, and installation instructions are available from Equipment Management Branch, Division of Engineering. Forest Service Drawings F84-01-02, and -03 are maintained by the San Dimas Equipment Development Center.

AVAILABILITY. A complete installation package is available upon request from the Stockton Equipment Depot. Total parts cost is approximately $325.

The selected devices as described on Drawing F84-02, Items 2 and 23 are manufactured by: Federal Sign and Signal Corporation
Signal Division
136th and Western Avenue
Blue Island, Illinois 60406

Distributed in California by:

(1) L.N. Curtis and Sons
4133 Broadway
Oakland, California 94611

(2) Halprin Supply Company
3804 South Broadway Place
Los Angeles, California 90037

REFERENCES. See R-5 Supplement No. 56, Section 618--2, FLEET EQUIPMENT MANAGEMENT HANDBOOK.

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WATER HANDLING EQUIPMENT GUIDE

Forest Service - Washington, D.C.

Amendment No. 1

March 1971

Digest:

A prototype of the Model 51 Slip-on Crew Tanker is now in service. The specification, construction drawings, and operating instructions are available. Enclosed is a 15-page description of the unit including a suggested tool and equipment list for your copy of the WATER HANDLING EQUIPMENT GUIDE.

Superseded Pages	New Pages
None	2.1.3--1 thru --15
6.12	6.12

WATER HANDLING EQUIPMENT GUIDE requests from the National Forests, States, Counties, and private individuals are handled by Regional Offices, except that out-of-Service organizations in the Southern Region are directed to State and Private Forestry in Atlanta, Georgia. Also, similar requests from within the Eastern Region are processed by S&PF in Upper Darby, Pennsylvania. Area Directors at Upper Darby and Atlanta, maintain distribution lists for all out-of-Service users in their respective areas. The printing of the GUIDE and Amendments is handled by the San Dimas Equipment Development Center under the direction of the Washington Office.

Additional copies of the WATER HANDLING EQUIPMENT GUIDE are available through these channels.

May we suggest you insert this letter of transmittal in the back of the GUIDE after completing the corrections.

Division of Fire Control
Washington, D.C.

Enclosures

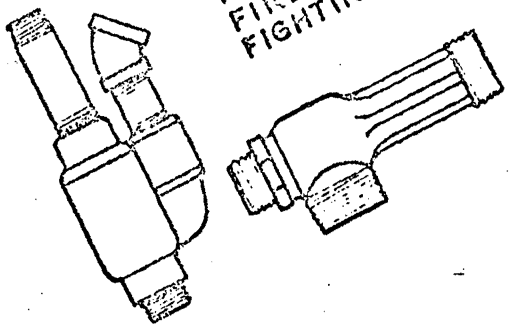
EQUIPMENT DEVELOPMENT REPORT NO. 20

OCTOBER 1953

(REPRINTED APRIL 1968)

Water Ejectors

FOR FOREST FIRE FIGHTING



FOREST SERVICE

U. S. DEPARTMENT OF AGRICULTURE

Also see 6.9-1+2+3

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WATER EJECTORS

Arcadia Equipment Development Center, U. S. Forest Service, Arcadia, Calif.

INTRODUCTION

Although EJECTORS have been used in industry for years, little effort had been made to apply them to the problems of fire fighting.

A project was proposed and assigned to the Arcadia Equipment Development Center to investigate the possibilities of application to fire fighting particularly with respect to obtaining water from sources normally classed as inaccessible to standard pumpers.

The results of this investigation have proven that EJECTORS* can be used effectively, efficiently, and economically and that they definitely have a place in Forest Fire Fighting.

This report is intended to summarize the findings and serve as a guide to those interested in possible uses.

Lifting water 100 feet with an EJECTOR.

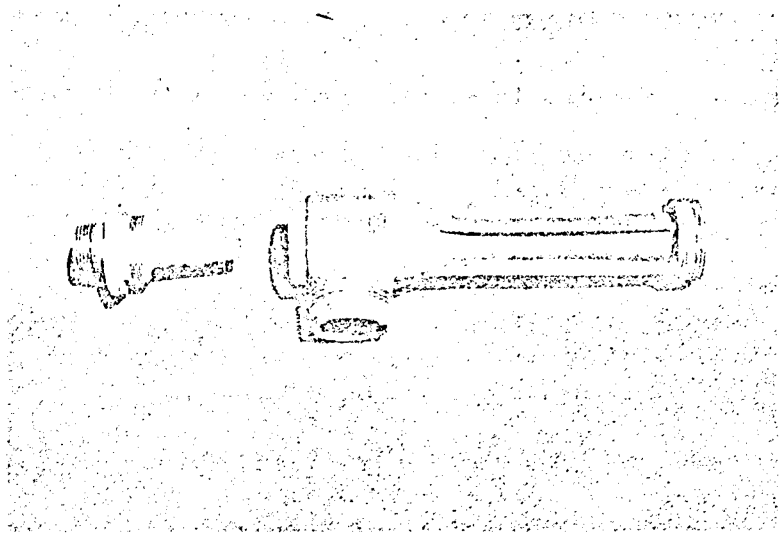
*The number of makes and models of ejectors included in the test and reported upon herein was necessarily limited. There are other makes available that have comparable performance and otherwise meet service requirements.

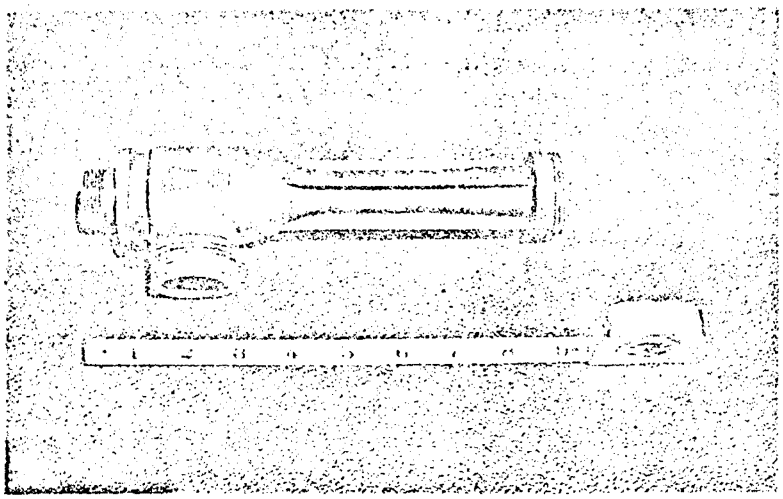
PART ONE

WHAT IS AN EJECTOR?

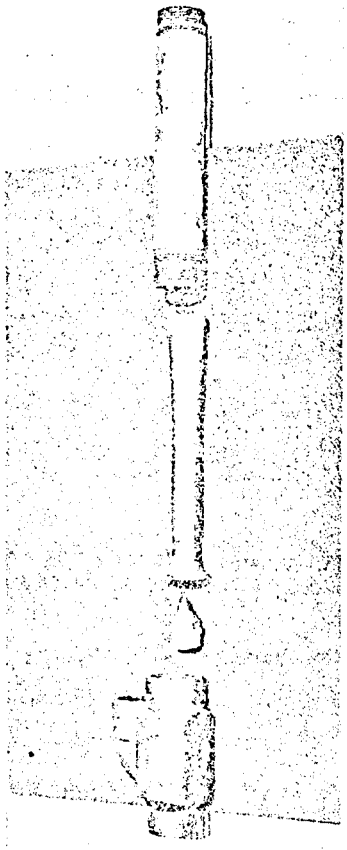
An EJECTOR is a simple inexpensive device having no moving parts, which can be used as a suction booster. Two types are shown below.

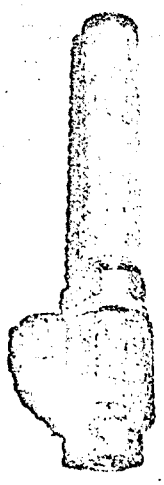
STRAIGHT TYPE





"U" TYPE

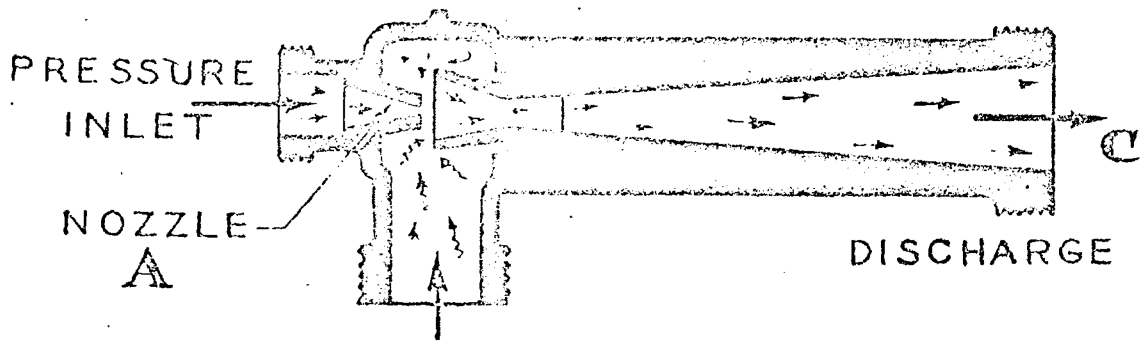




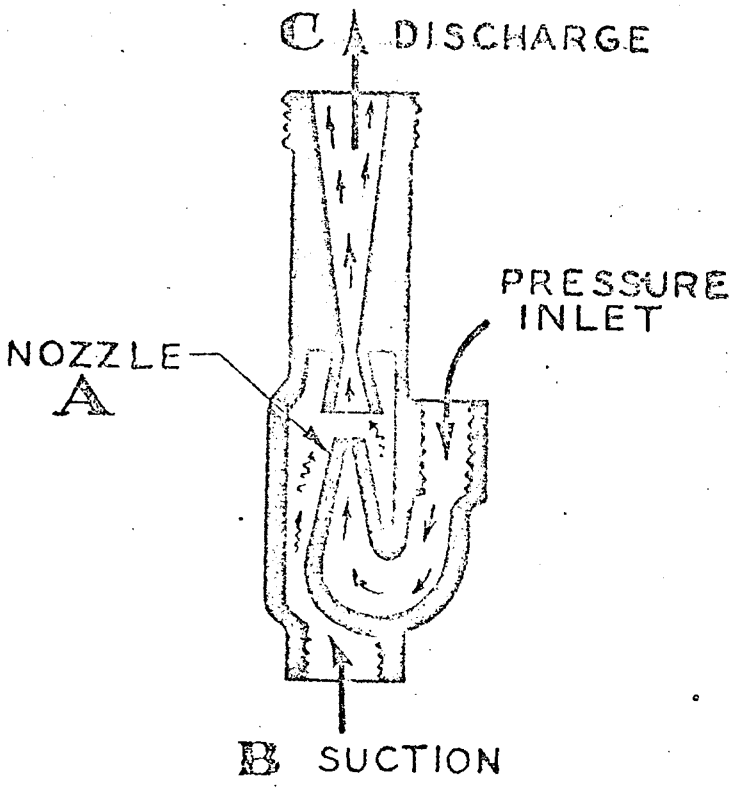
They come in sizes having varying capacities. The EJECTORS tested had input capacities of from 5 to 50 gallons per minute; weighed from 2 to 15 pounds; and cost from $5.00 to $25.00.
Other units having higher capacities are available.

HOW DOES THE EJECTOR WORK?

Water is pumped to the pressure inlet and issues from nozzle "A" in a high velocity stream. The high velocity stream picks up additional water from the suction inlet "B", and delivers the combined flow through the discharge "C" under pressure.

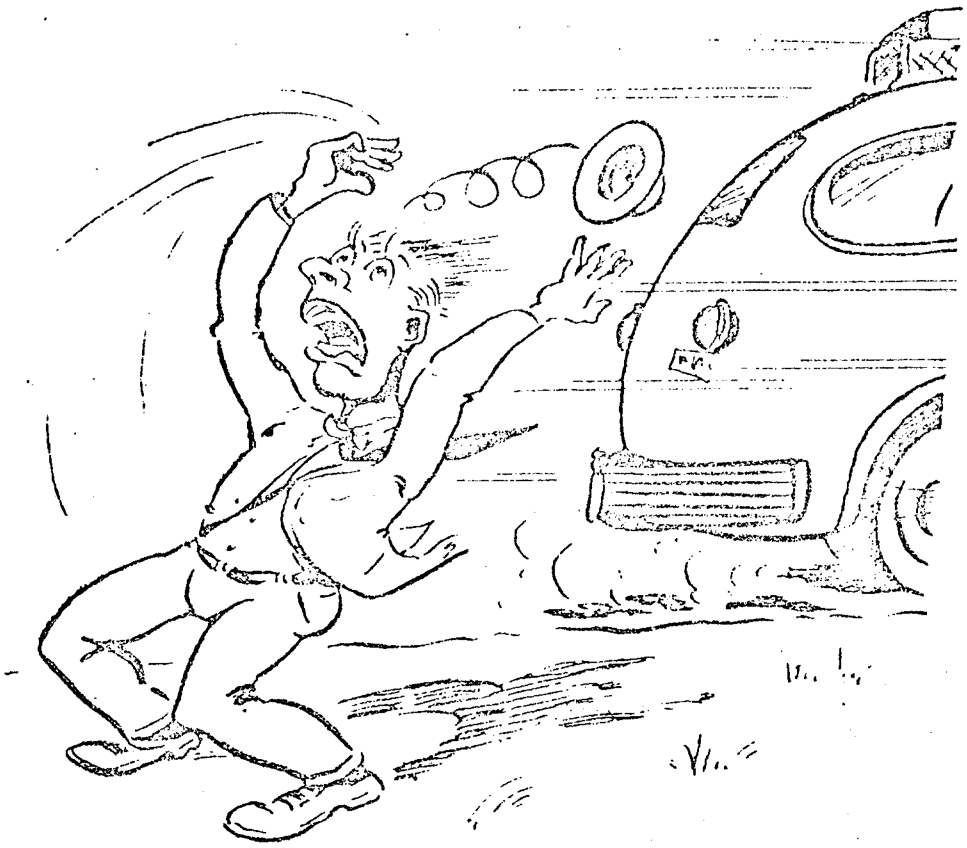


STRAIGHT TYPE



"U" TYPE

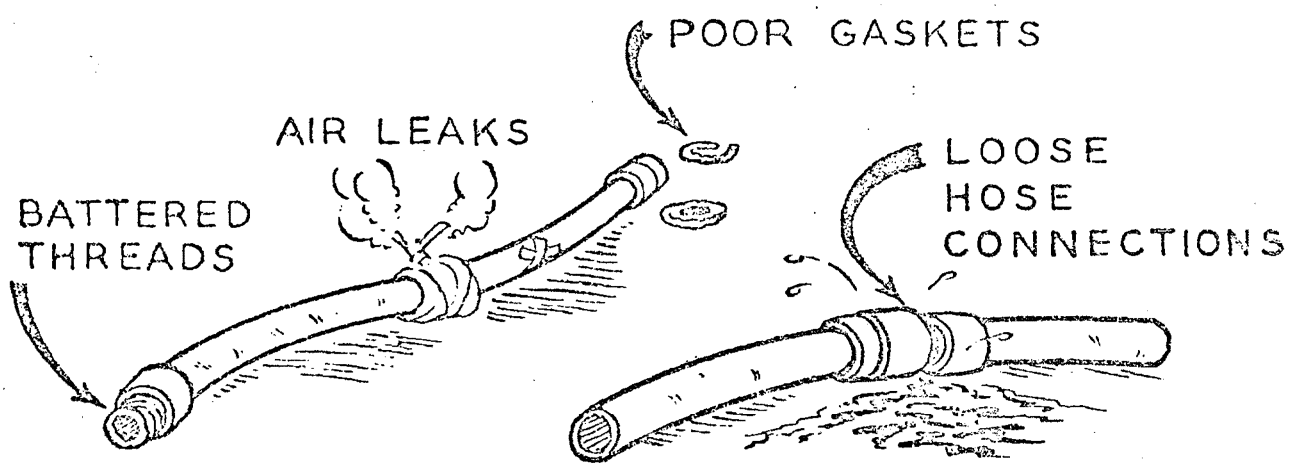
The action of this high velocity stream picking up additional water is similar to the condition existing when a bus or truck speeds by and takes your hat along.



WHY USE EJECTORS?

When a water pump drafts water vertically, it removes the air under atmospheric pressure from the inside of the suction hose, thus creating a vacuum. The atmospheric pressure at sea level, exerts a pressure of 14.7 pounds per square inch on the water that is in the supply reservoir. This pressure is capable of lifting a column of water 33.9 feet in height, or 2.3 feet for every pound of pressure. If a pump could produce a perfect vacuum, the greatest height it could lift water from a supply reservoir at sea level would be 33.9 feet. Obviously, no pump can quite produce a perfect vacuum. A good fire pump at sea level can lift water approximately 20 feet and maintain suction.

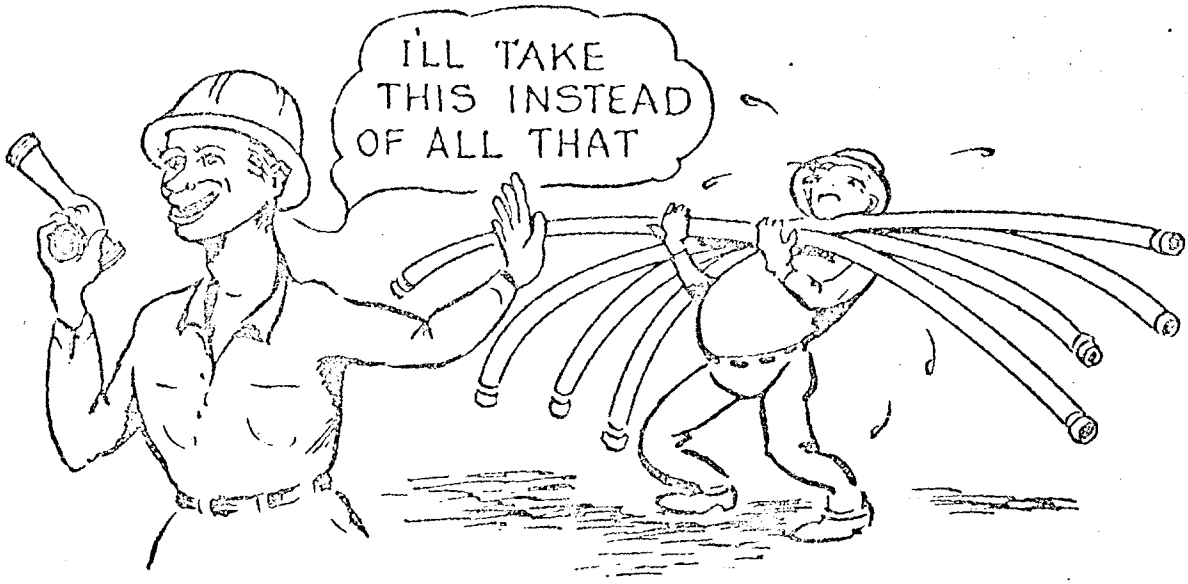
For lifts above 20 feet, the use of EJECTORS is recommended. In fact, it might be advisable to use EJECTORS for all drafting to eliminate the many suction difficulties encountered which often result in ruined pumps. It only takes a loose suction hose coupling, a leaky gasket, poor pump packing, or some other small leak to seriously affect the ability of the pump to lift water.



EJECTORS employ pressure for picking up water from remote sources and lifting it to the fire truck, so that the cotton jacketed rubber lined hose carried on the truck may be used. Connections may be only hand tight since small leaks will not affect operation to any extent.

ADVANTAGE OF EJECTORS

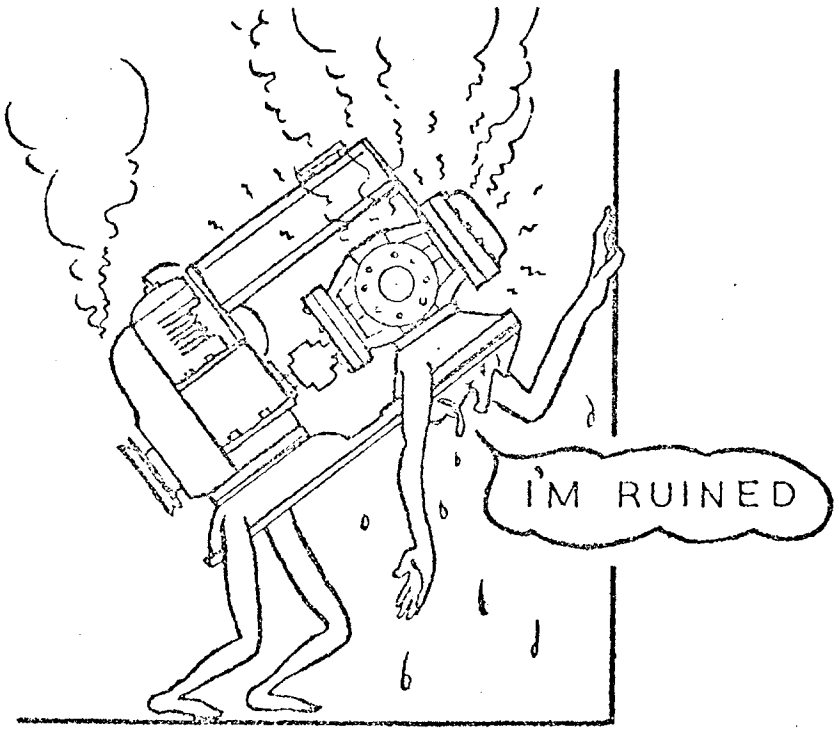
1. No Suction Hose is Necessary.



LESS COST LESS WEIGHT

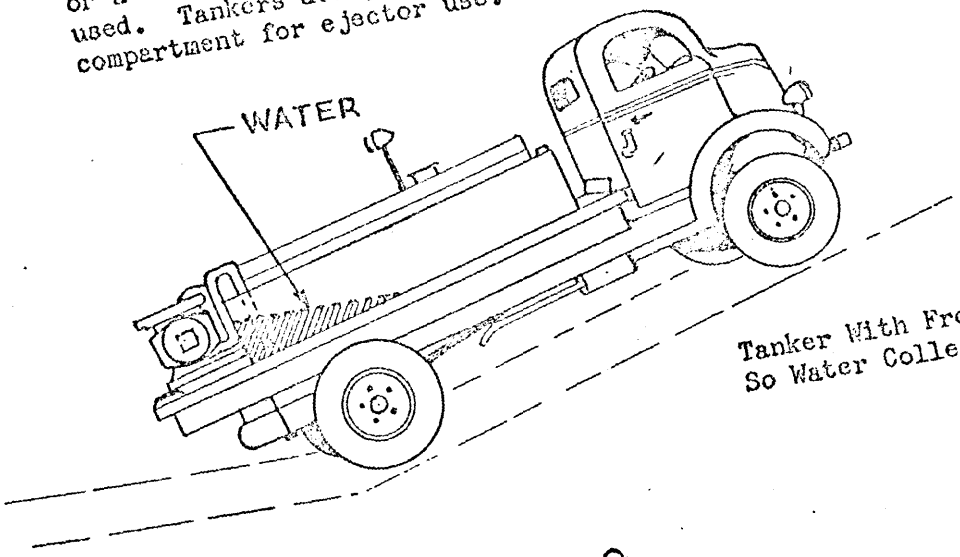
NO SPECIAL COMPARTMENTS NECESSARY ON THE TRUCK FOR CARRYING HARD SUCTION HOSE.

2. No more pumps ruined by running dry when trying to draft.

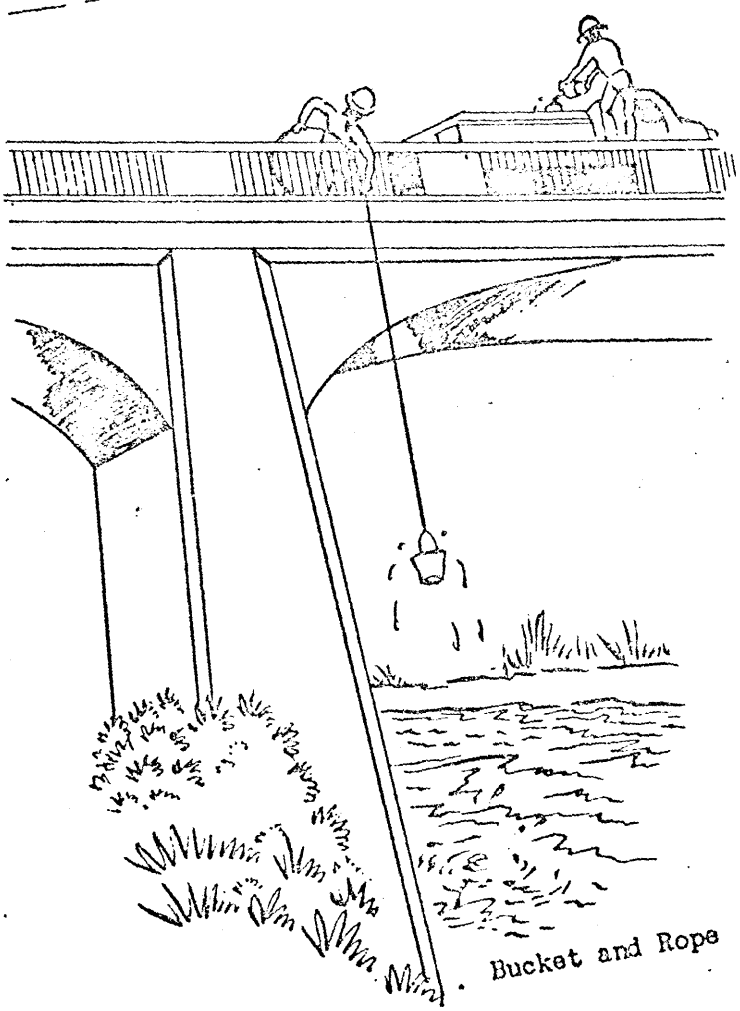


CAUTION in use of EJECTORS -

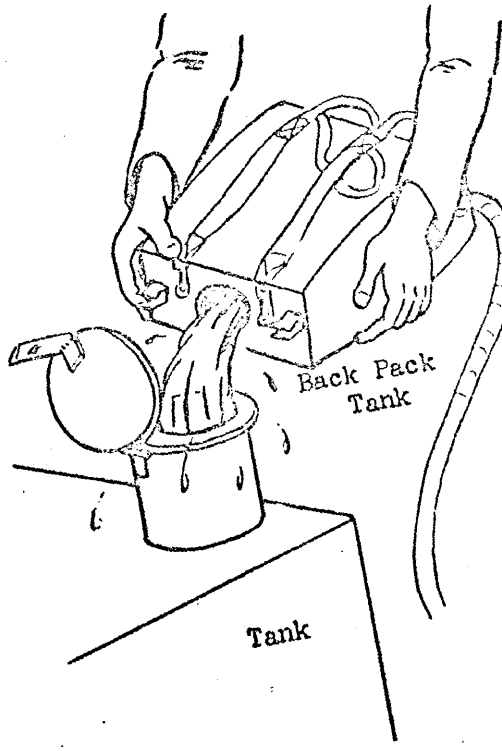
RESERVE WATER - Sufficient reserve water must be left in the tank, or secured by some means before EJECTOR action can be started. An auxiliary tank, back pack tank, reserve suction in the main tank, or a bucket on a rope to dip reserve water from the source can be used. Tankers designed in the future should provide for an auxiliary compartment for ejector use.



Tanker With Front End Higher So Water Collects At Suction Pipe

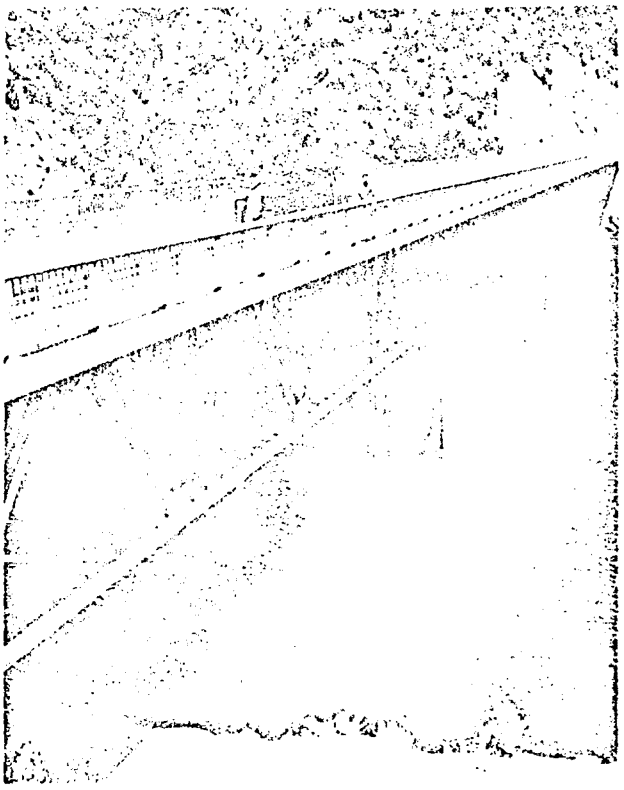


Bucket and Rope



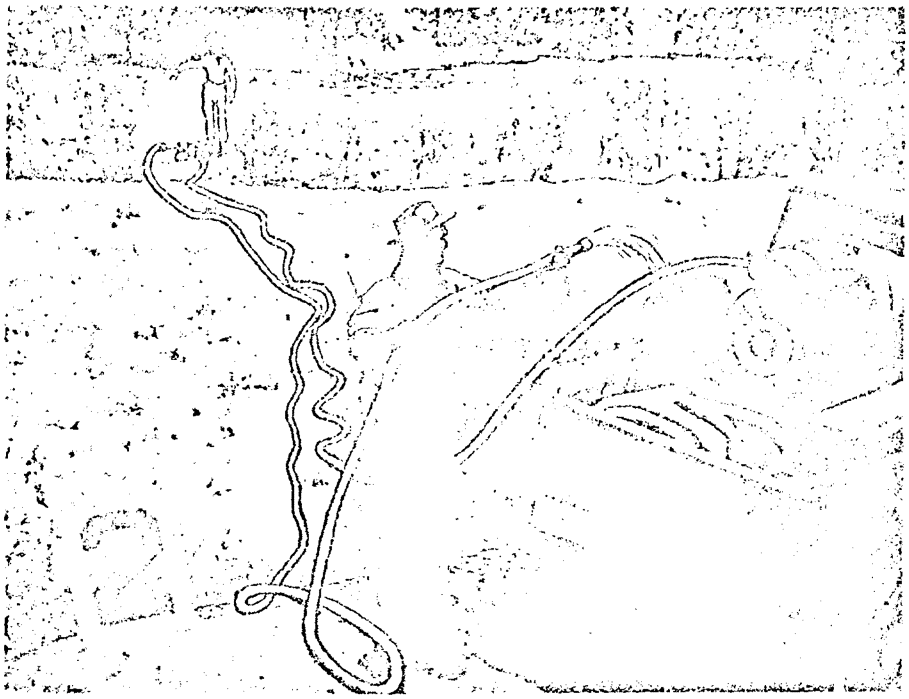
WHERE CAN EJECTORS BE USED

Water sources that are normally inaccessible due to terrain, fences or other obstructions, can be used.

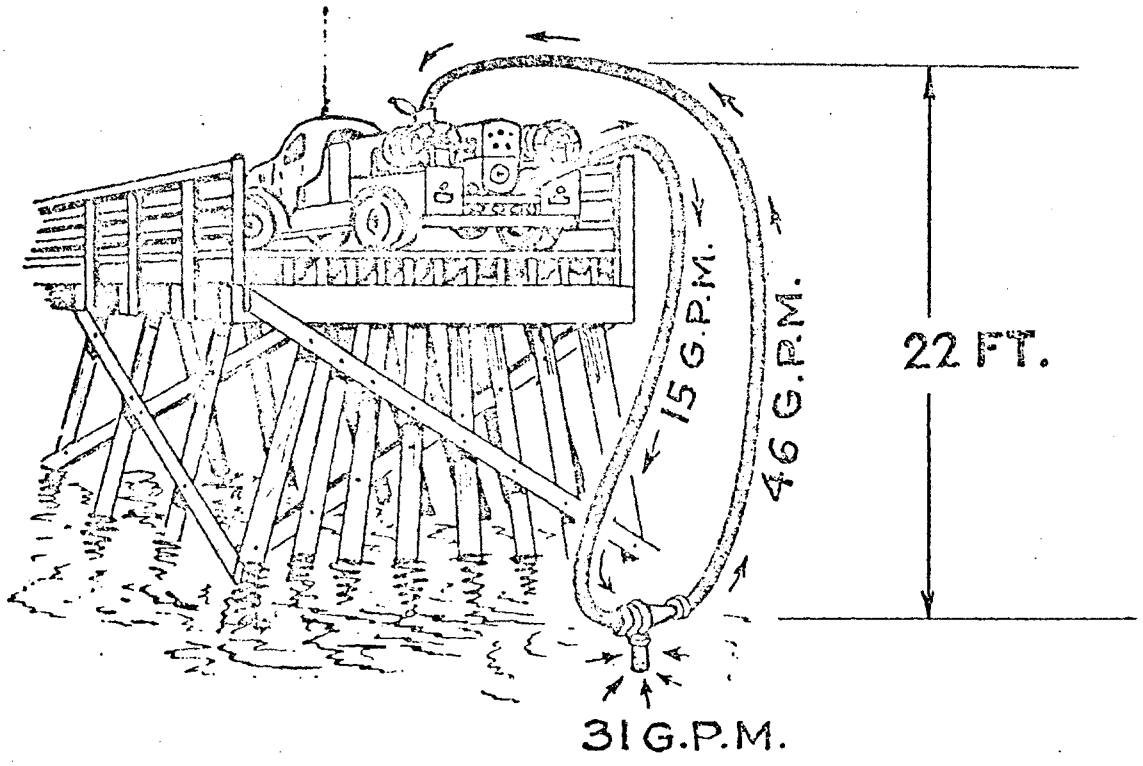


Water can be lifted from rivers and creeks, bridge crossings, even though water level is 100 feet below the road bed.

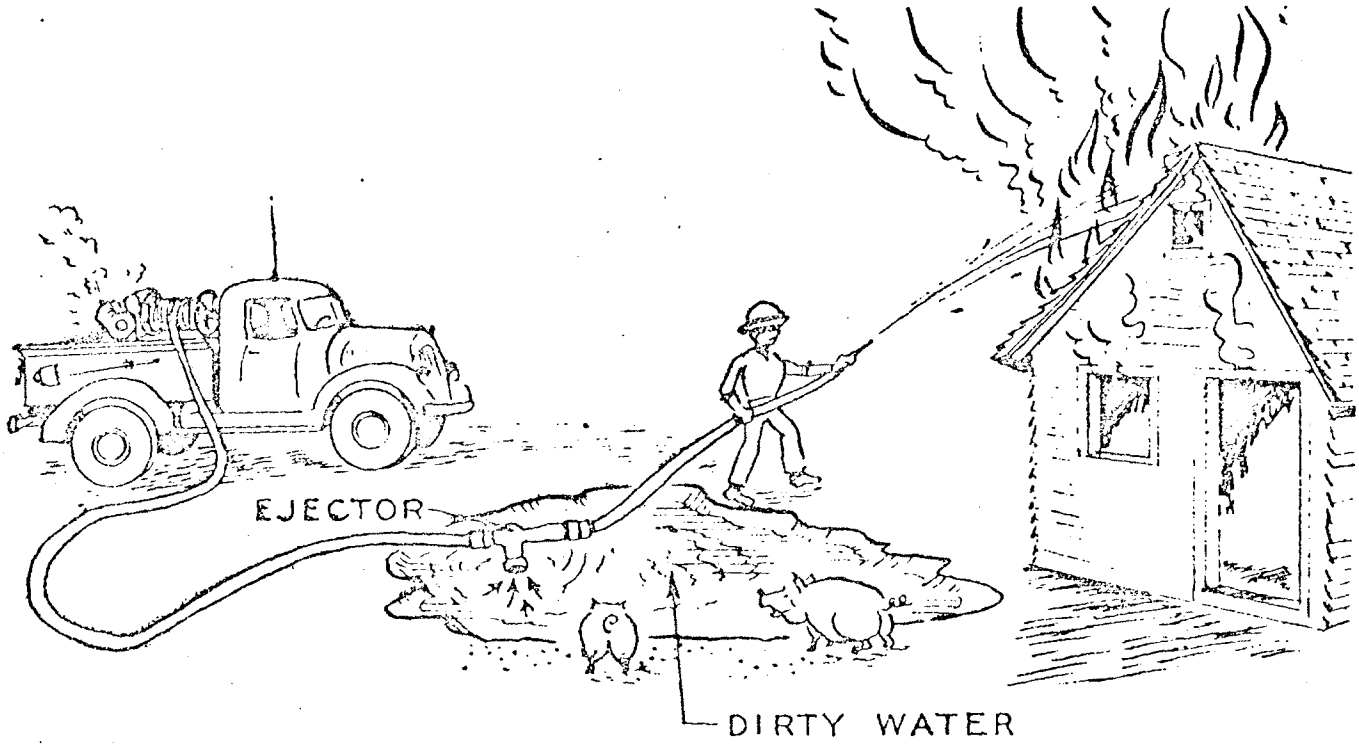
Rivers and lakes up to 300 feet from the road are readily available for filling the fire truck.



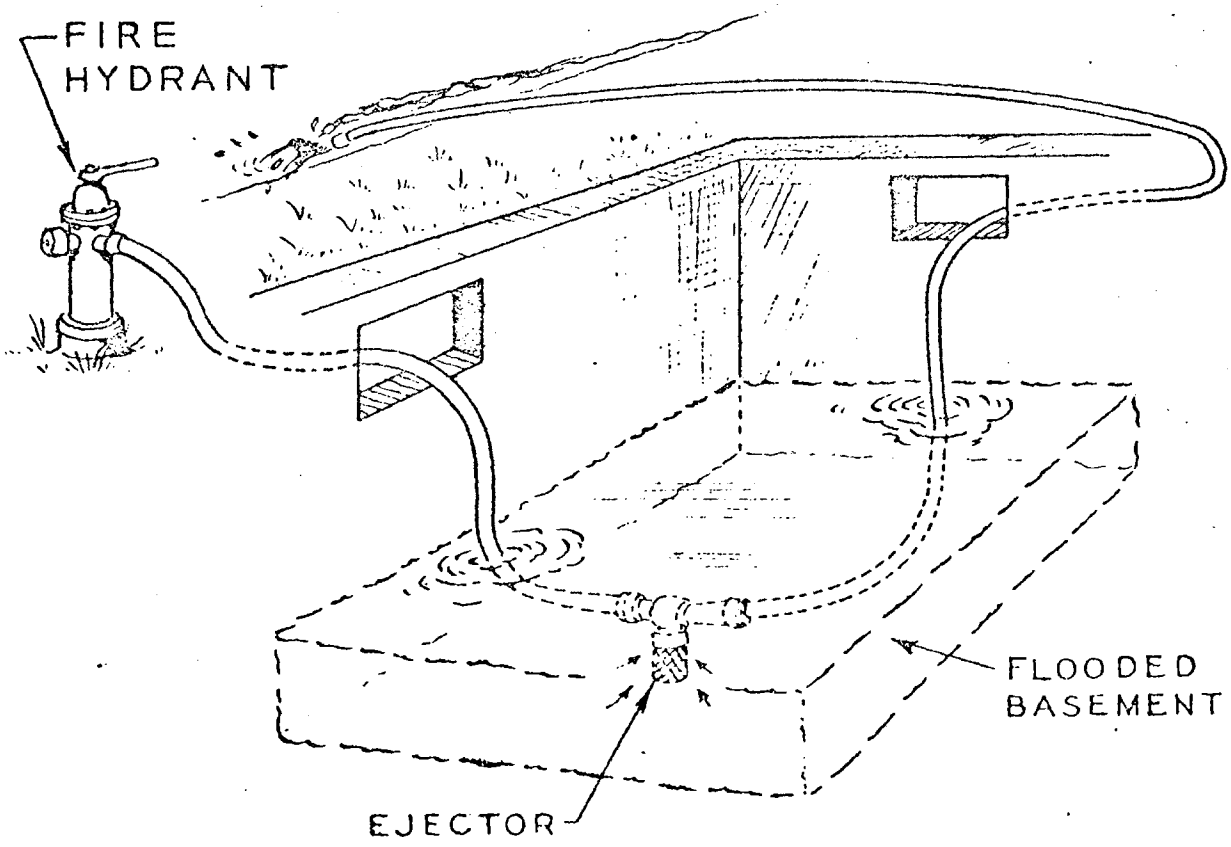
A small pumper becomes a big pumper under ordinary drafting conditions. By using an EJECTOR, a pumper can fill the tank at a rate equal to two times its output.



Dirty sand laden water can be utilized to put out fires and up to 3 times pumper capacity can be applied since none of the dirty water passes through the pump.



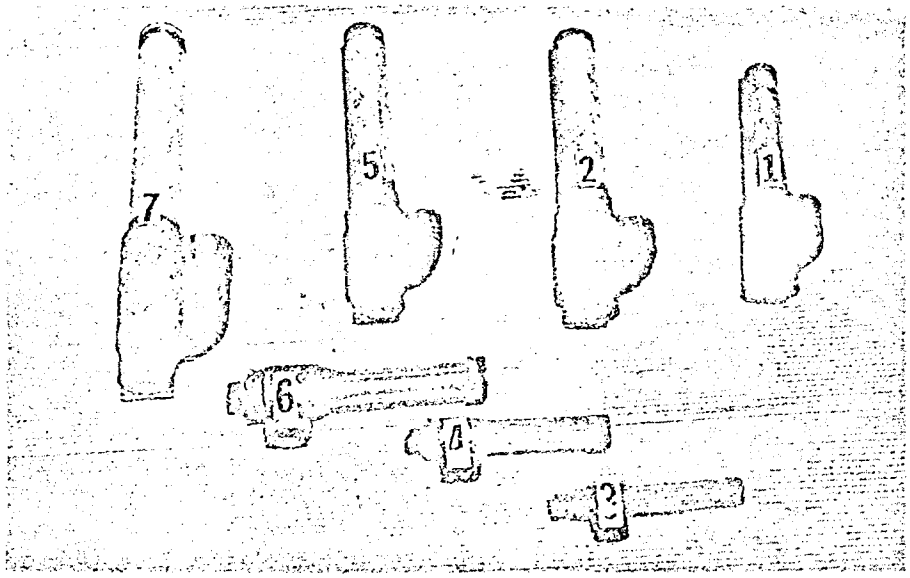
Use to "pump out" basements without using pumper at all.



PART TWO

HOW TO SELECT AN EJECTOR?

It is necessary to select EJECTORS matched to the pumper and conditions under which they will be used. The units shown are those tested. The numbering is used to identify them in the tables covering capacities and uses.



Normally, two EJECTORS are necessary for each pump to insure efficient operation over a broad range of conditions. However, in some cases a single EJECTOR will suffice. This will be explained later.

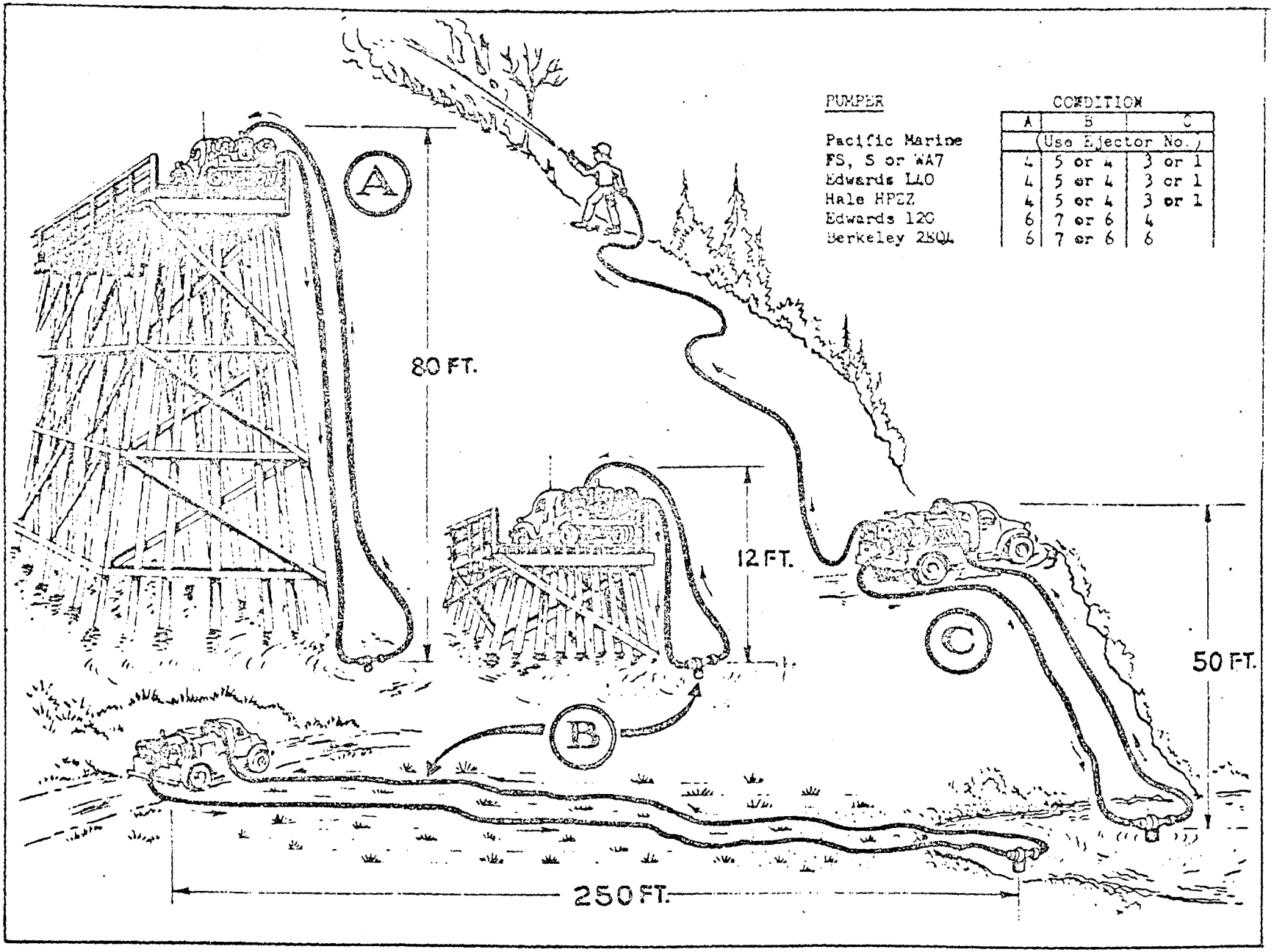
There are three basic conditions where EJECTORS can be used successfully. They are:

1. High lift using approximately full pump capacity, for tank filling. Refer - Sketch "A", page 12.

2. Low lift using approximately full pump capacity, and returning the maximum amount of water for rapid tank filling. Refer - Sketch "B", page 12.

3. Using one half the pumper output to operate the EJECTOR, for keeping the tank full while using the other half for fire suppression. Refer - Sketch "C", page 12.

The three conditions of operation are shown in the sketch which follows. EJECTORS to use, depending on pumper size, are also shown.



PUMPER	CONDITION		
	A	B	C
	(Use Ejector No.)		
Pacific Marine FS, S or WA7	4	5 or 4	3 or 1
Edwards LLO	4	5 or 4	3 or 1
Hale HPDZ	4	5 or 4	3 or 1
Edwards 120	6	7 or 6	4
Berkeley 25QL	6	7 or 6	6

The tabulation of the few pumpers and matching ejectors shown on Page 12 illustrates a simple way of presenting this information when the makes and model of the pumpers to be used are known. It is possible to select the EJECTOR to be used with any pumper simply by knowing the operating condition, normal pump output in gallons per minute, and the normal pump discharge pressure in pounds per square inch. By referring to the table on page 15, which gives the capacity of EJECTORS, a unit within the range covered by the table can be selected.

For example: Suppose we have a pumper rated at 25 gallons per minute at 200 pounds pressure per square inch. It is desired to pick EJECTORS matched to the pumper for conditions A, B and C, page 12.

FOR CONDITION "A". High lift with maximum tank filling.

Referring to the bottom of Table I, page 15, we find figures indicating the amount of water pumped to operate each EJECTOR. Opposite the pressure of 200, we find 24.4 gallons per minute listed for EJECTOR #6. Now start at top of the page and observe figures down the column for EJECTOR #6. We find that the amount of pickup water, at 200 psi, stays at 32.8 gpm, regardless of lifts up to 69 feet. For a lift of 92 feet, pickup water has dropped to 19.9 gpm. Since we are pumping into the EJECTOR 24.4 gpm, this can still be considered efficient operation. In this case, the return line from EJECTOR to the tank is carrying 19.9 plus 24.4 or 44.3 gpm. For a 115 foot lift, the amount of pickup water is 4.8 gpm, and the blank space indicates that it will not lift water 138 feet. EJECTOR #6 would be selected for this condition.

Figures used in this example are underlined on the chart.

FOR CONDITION "B". Low lift with maximum tank filling and a pumper rated at 25 gpm at 200 psi.

For low lifts (below 50 feet), high pressures are unnecessary for EJECTOR operation. The object here is to get maximum flow to fill a tank rapidly. As a rule of thumb, one foot lift for each three pounds per square inch of pressure, is the maximum for efficient operation. Thus, if the lift is 50 feet, the psi necessary is 150. Referring to the bottom of Table I, we find both EJECTORS #6 and 7 having operating requirements near 25 gpm at 150 psi. EJECTOR #7 takes 25 gpm while #6 takes 20.8 gpm. For lifts below 23 feet, EJECTOR #7 affords maximum pickup at 55.2 gpm; for lifts of 46 feet, 37.6 gpm are picked up. EJECTOR #7 would be unable to lift water 69 feet at 150 psi. By comparison, EJECTOR #6 will pick up 32.9 gpm and lift it 23 feet at 150 psi, and the same amount at 46 feet. At the 69 foot lift, the volume of pickup water is down to 17 gpm, but still it is able to operate satisfactorily.

The conclusions here are as follows: EJECTOR #7 will give the greatest volume of water and would be selected for more or less level areas. EJECTOR #6 will give fair returns under the same conditions, and continue to operate for higher lifts. In general, EJECTOR #6 would be selected for condition "B" because of the possibility of wider application.

Figures used in this example are identified in the table by parenthesis.

FOR CONDITION "C". Maintain full tank and supply water to the line. Pumper rated at 25 gpm and 200 psi.

It should be noted that for conditions "A" and "B" it is advisable to use, as closely as possible, the full capacity of the pumper to operate the EJECTOR. For condition "C", approximately 1/2 of the pumper output should be used in order to provide excess for the nozzle, and yet maintain the tank full without excessive overflow. Careful calculations are necessary for proper selection.

Referring to the bottom of Table I, note that EJECTORS #2 and #3 have operating requirements at 200 psi, of approximately one half the pumper output, namely 9.6 and 10.4 gpm. EJECTOR #2 takes 9.6 gpm to operate, leaving 25 minus 9.6 or 15.4 gpm to divert to the fire. This EJECTOR will pickup 16.9 gpm and deliver it back to the tank for lifts up to 46 feet. It is plain to see that it is possible to overflow the tank with this combination.

EJECTOR #3 uses 10.4 gpm to operate, leaving 14.6 to discharge on the fire. It picks up only 11 gpm (see Table I) so it is quite evident that if the full 14.6 gpm were discharged to the fire, 3.6 gpm would be pumped out which were not replaced, and the tank would soon be dry.

NOTE: Computations are based on the assumption that the discharge line has a nozzle tip sufficiently large to discharge 14.6 gpm at 200 psi.

TABLE I

CAPACITY OF EJECTORS

SUCTION CAPACITY OR PICKUP WATER GPM

Lift in Feet	Lift in PSI	Operating Pressure in PSI	EJECTOR NUMBERS #1	#2	#3	#4	#5	#6	#7
		50	5.7	4	5.3	7.2	1		7.2
		100	6.9	16.1	11.6	20.3	27.8	31.3	47.8
(23)	10	150	7.1	17.3	11.2	20.9	31.2	(32.9)	(55.2)
		200	6.4	16.9	11.1	21	31.2	32.8	54.6
		250	6.6	16.8	11	20	30.9	31.8	54.6
		50							
		100	6.9	1.1	6.8	8.2	1.4	14.8	
(46)	20	150	7.1	16	11.2	18.2	22.6	(32.9)	(37.6)
		200	6.4	16.9	11	21	31.2	32.8	54.6
		250	6.6	16.8	11	20	30.9	31.8	54.5
		50							
		100	3.3						
(69)	30	150	7.1	1.4	8.6	8.8		(17)	(-----)
		200	6.4	13.9	11	17.8	18	32.8	29.4
		250	6.6	16.8	11	20	30.7	31.8	53.6
		50							
		100							
92	40	150	6		2.2				
		200	6.4	1.6	9.9	9.9		19.9	
		250	6.6	13.7	11	17.8	11.4	31.8	35
		50							
		100							
115	50	150	1.0						
		200	6.4		5.3			4.8	
		250	6.6	2.9	11	11.1		24.7	
		50							
		100							
138	60	150							
		200	4.5					---	
		250	6.6		7.5	8.5		9.5	
Water pumped		50	3.9	4.9	5.3	7.8	7.4		14.4
to Operate		100	5.7	6.6	7.5	10.8	10.6	17.7	20.6
EJECTOR		(150)	7.2	8.1	9.1	13.2	13	(20.8)	(25)
G.P.H.		200	8.3	9.6	10.4	15.4	14.9	24.4	28.7
		250	9.3	10.5	11.4	17.6	16.6	27.5	32.4

EJECTOR DESCRIPTION

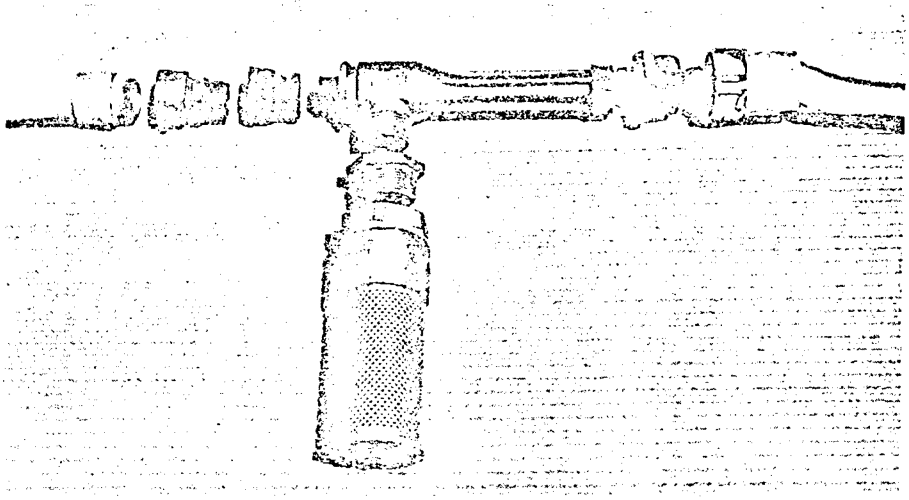
#1 Berkeley 00-9-18 or equal
#2 Berkeley 0-10-28 or equal
#3 Penberthy 62 A or equal
#4 Penberthy 63 A or equal
#5 Berkeley 0-12-38 or equal
#6 Penberthy 64 A or equal
#7 Berkeley 1-17-52 or equal

Note:- Other brands available commercially - Specify similar charactistics.

PART THREE

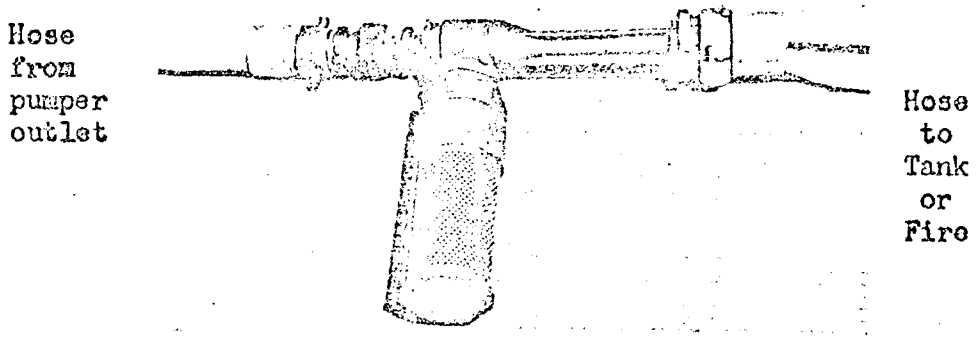
HOW TO USE EJECTORS.

"FITTING UP" the Straight Type.



EJECTORS, as furnished, have iron pipe threads. Additional fittings are necessary to adapt EJECTORS for use with fire hose threads. A swivel connector on the pressure inlet is desirable. Both types of EJECTORS use similar fittings as listed on page A-12 of Appendix. Footvalve strainers should be used with all EJECTORS.

"HOOKING UP"

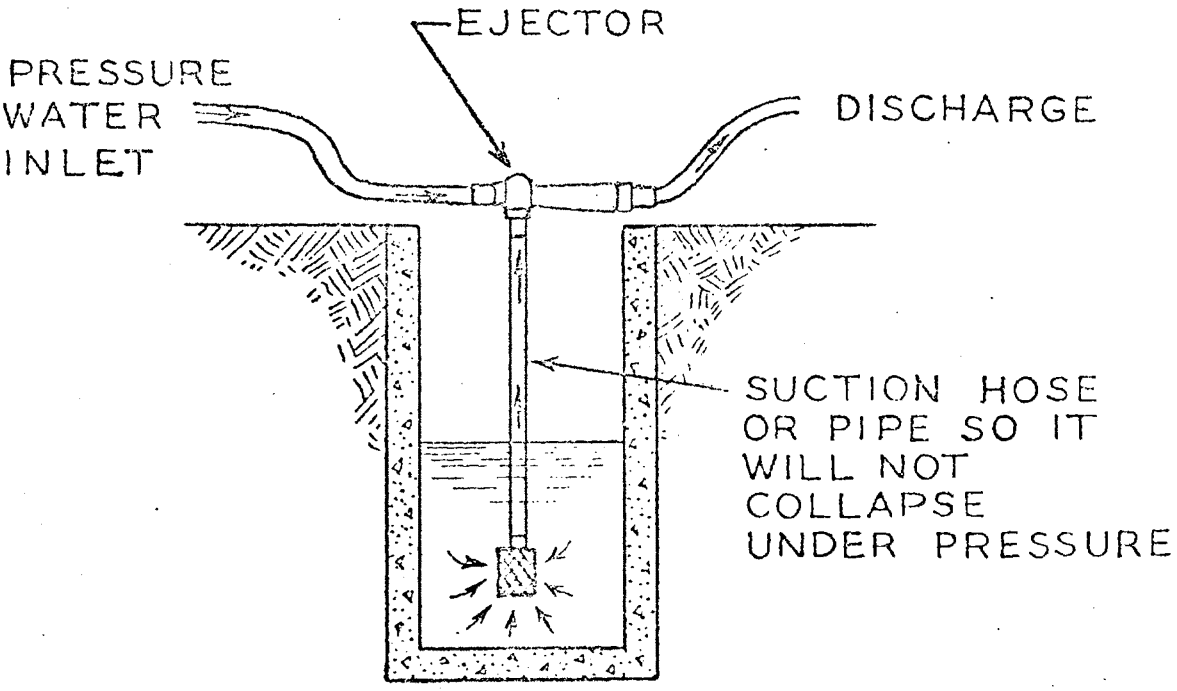


"SUBMERGE EJECTOR"

For best results and trouble free operation, the EJECTOR should be submerged sufficiently deep to prevent an air funnel from forming. If the water is to be returned to the tank, the suction intake should be protected from sand and silt.

It is important that there be no kinks in the discharge line that would increase resistance to flow.

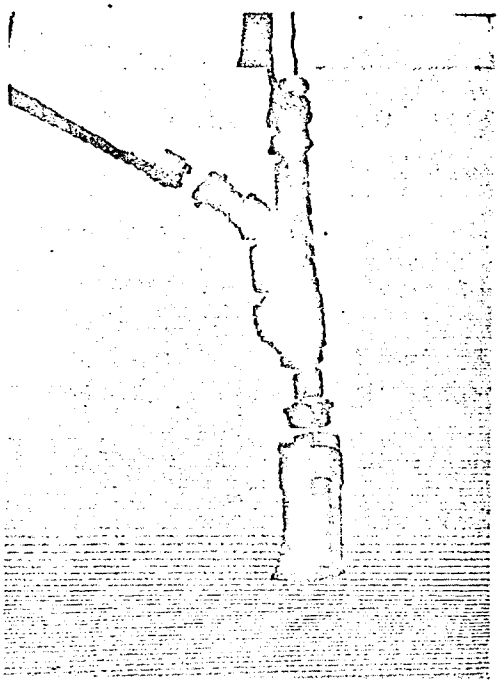
EJECTORS CAN BE USED WHEN NOT SUBMERGED.



This type of hook-up should be employed only when absolutely necessary, because of possible failures common to suction operation. Also, the height to which water can be lifted is considerably reduced by each foot added to suction lift.

"FITTING UP" the "U" Type.

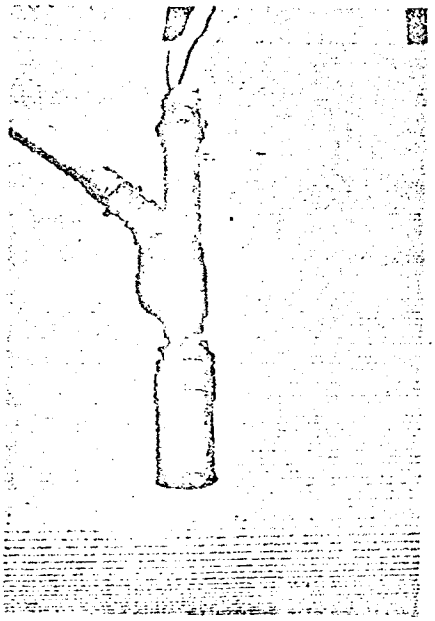
The smallest opening is the intake on which the swivel connection is placed. Notice that a 45°-ell is necessary in order to make connections.



"HOOKING UP"

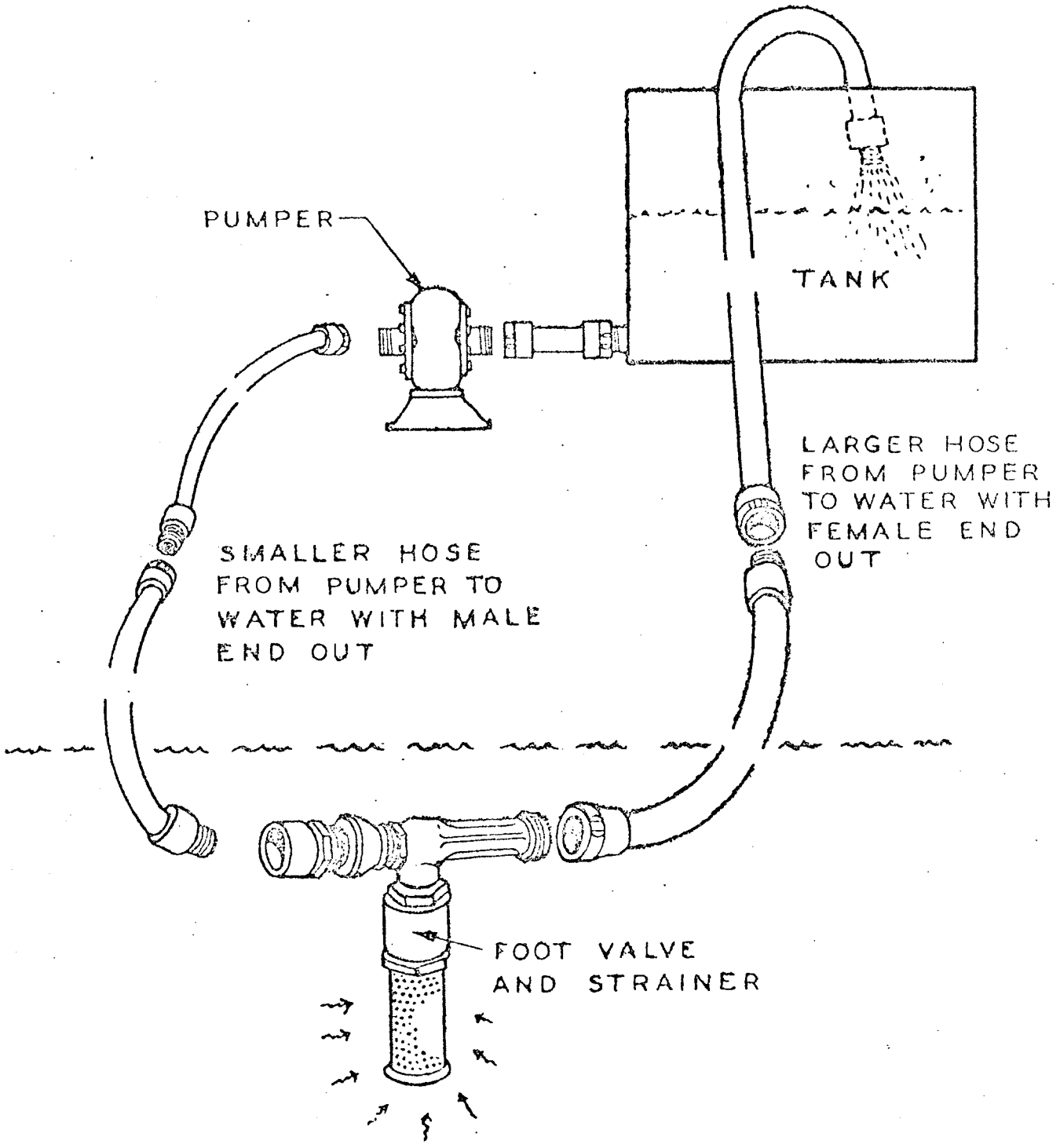
Hose to tank or fire.

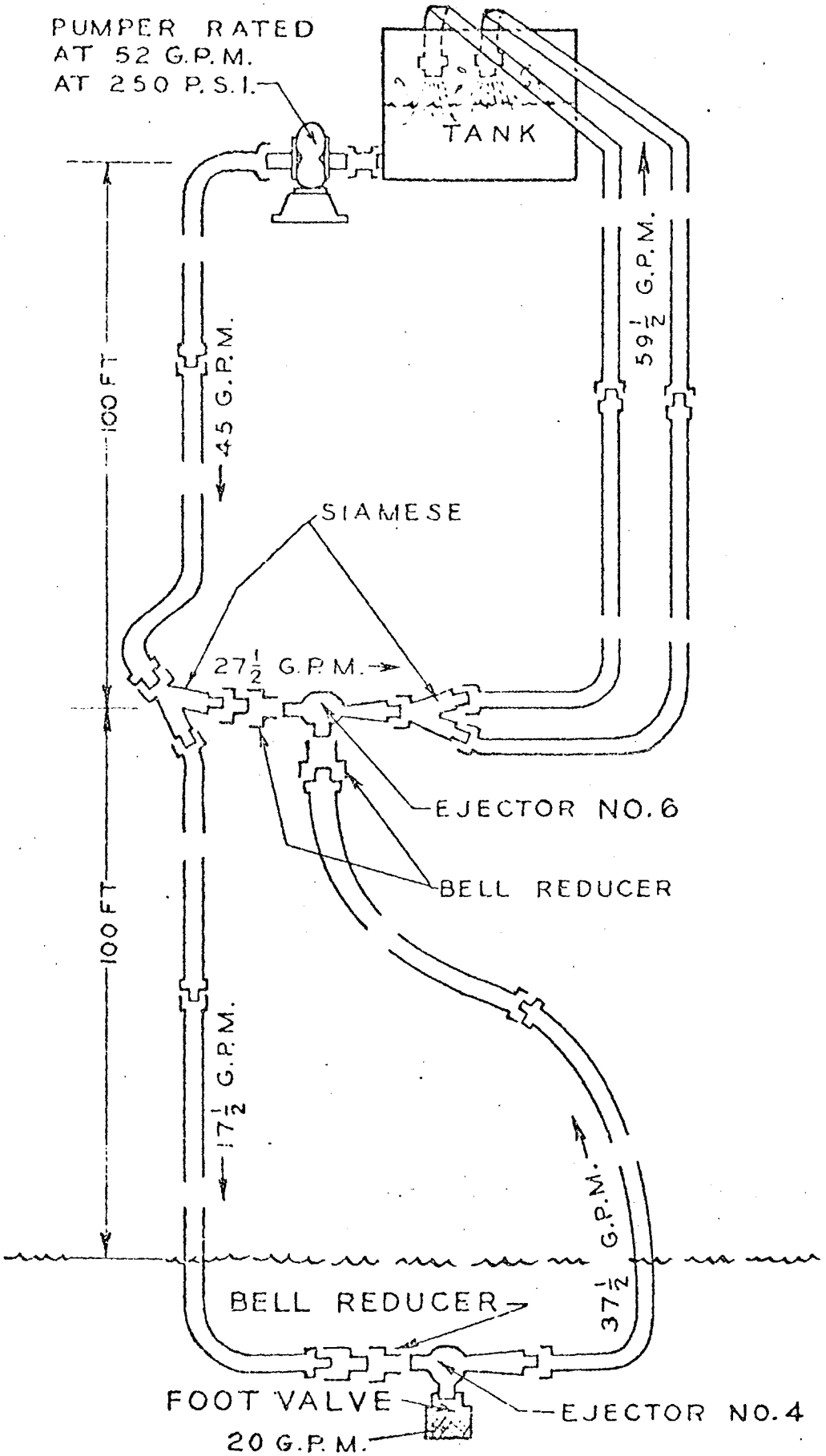
Hose from pumper

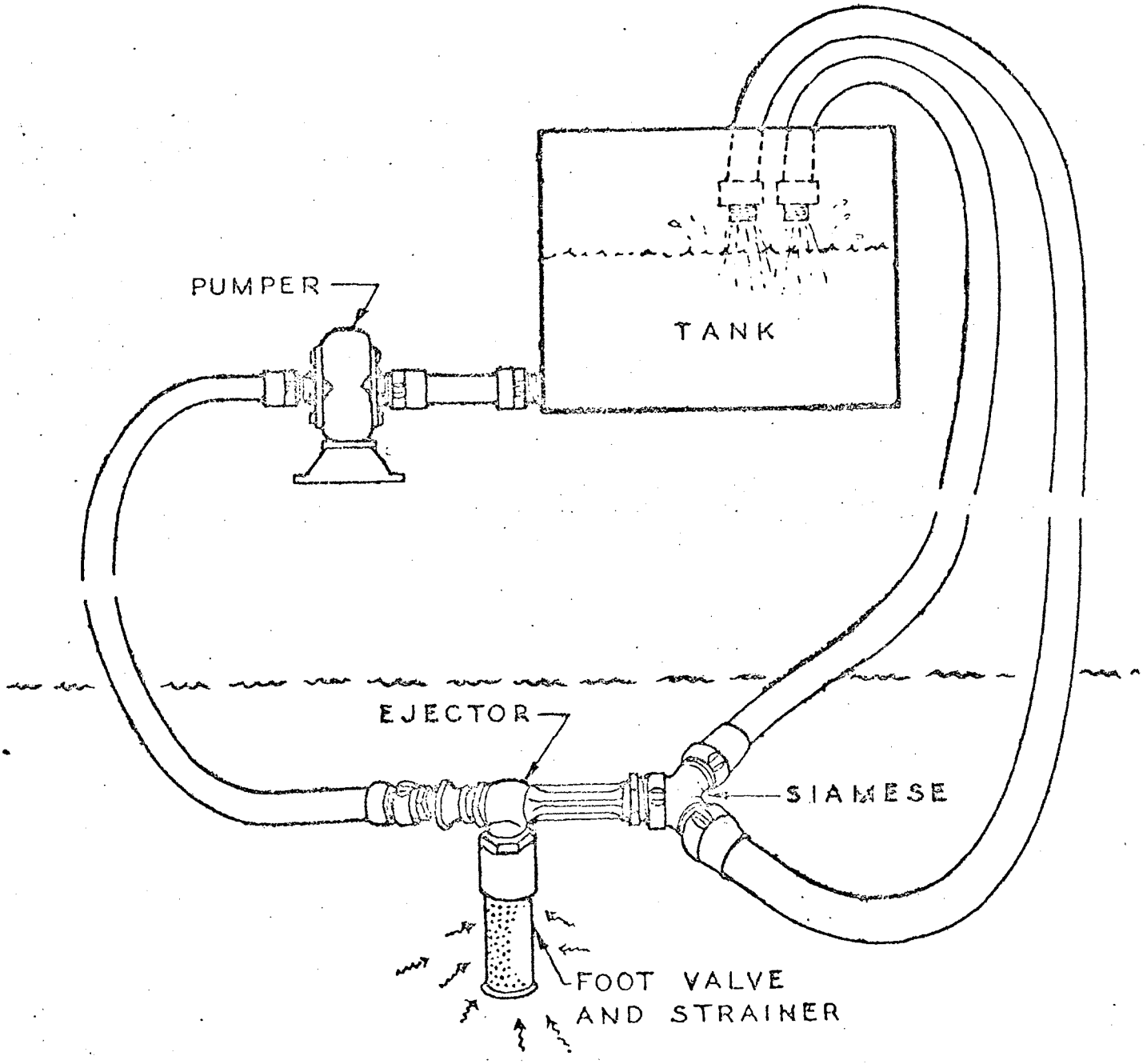


EJECTOR SUBMERGED

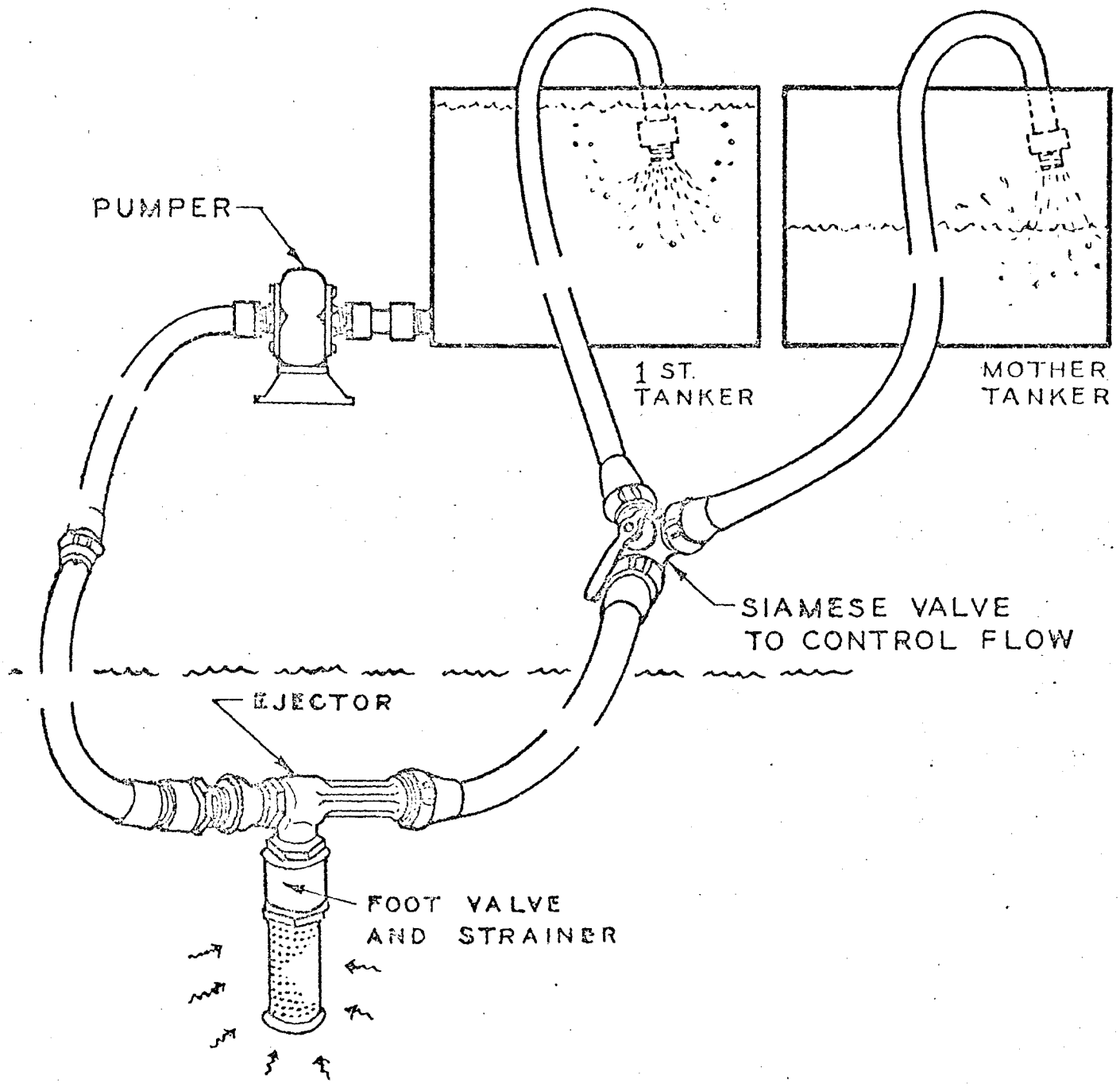
LAY HOSE FROM TANK TRUCK TO WATER SOURCE


PUMPER
TANK
LARGER HOSE FROM PUMPER TO WATER WITH FEMALE END OUT
SMALLER HOSE FROM PUMPER TO WATER WITH MALE END OUT
FOOT VALVE AND STRAINER


PUMPER RATED
AT 52 G.P.M.
AT 250 P.S.I.
TANK
100 FT
45 G.P.M.
59½ G.P.M.
SIAMESE
27½ G.P.M.
EJECTOR NO. 6
BELL REDUCER
100 FT
17½ G.P.M.
37½ G.P.M.
BELL REDUCER
FOOT VALVE
20 G.P.M.
EJECTOR NO. 4


PUMPER
TANK
EJECTOR
SIAMESE
FOOT VALVE
AND STRAINER

HOOKUP FOR FILLING MOTHER TANKER



FOOTVALVES.

It was previously mentioned that a footvalve and strainer should be used with all EJECTORS. The use of a strainer needs no comment at this time, but it might be well to mention the importance of the footvalve in EJECTOR operation. Since water is picked up by water being pumped thru the EJECTOR, obviously sufficient water must be available to the pumper to fill the hoses and start water returning to the tank. It is desirable, that once the hoses are filled, water is not lost in the event the engine stops, or in case of repeated fills of fire trucks at one location. A spring type footvalve, attached to the suction side of the EJECTOR, prohibits loss of any water. The ordinary gravity type of footvalve might not suffice as it would not always be in position to close by gravity.

A spring closing footvalve strainer has been tested with EJECTORS, and found to operate efficiently without affecting performance, providing one is used having sufficient opening around the spring closing disc to handle the volume of pickup water. For Penberthy and Barkeley EJECTORS, it is recommended that one thread size larger than the EJECTOR suction be ordered and attached by means of a bushing reducer. For instance, the Penberthy 62A EJECTOR has a 3/4 inch suction, so it should receive a 1 inch footvalve. For 1 inch and 1-1/4 inch suction, use 1-1/4" and 1-1/2" footvalves respectively.

The amount of reserve water needed will vary with the hose zes used, and the distance from the pumper to the water source. e minimum amount for each hundred feet of hose between pumper and urce, is given in the table below:

JECTOR umber	Pressure Inlet Maximum Flow GPM	Pressure Inlet Hose Size	Discharge Maximum Flow GPM	Discharge Hose Size	Reserve Water per 100 Ft.
1	9.3	3/4"	16	1"	10
2	10.5	3/4"	27.5	1½"	10
3	11.5	3/4"	22.5	1½"	10
4	17.5	3/4"	38.0	1½"	15
5	16.5	3/4"	47.5	1½"	15
6	27.5	1"	59.0	2"	25
7	32.5	1"	87.0	2"	25

It should be explained that the smallest size of hose, which will carry the volume of water efficiently, is listed. The reason for this is that less reserve water is necessary to fill the smaller hose. Of course larger hose can be used, but more reserve water will be required.

As a matter of information, 11 feet of 1½ inch hose holds 1 gallon of water, whereas it takes 25 feet of 1 inch hose to hold 1 gallon.

FRICTION LOSS IN HOSE AS APPLIED TO EJECTOR USE.

Friction loss must be carefully considered in EJECTOR operation. Because of the size of hose commonly carried by forest fire fighting equipment, the use of EJECTORS rated at less capacity than the pumper is sometimes recommended. It will be noted from the previous chart that a 2 inch hose is necessary for the two larger EJECTORS listed. The reason for this is quite plain when EJECTOR performance and friction loss in hose are carefully analyzed. (Refer to page A-2 in Appendix for friction loss in hose.)

The following example will explain this:

At 250 psi, the #7 EJECTOR takes 32½ gallons per minute to operate efficiently, so the line from pumper to EJECTOR is 1½ inch hose. Flow from the EJECTOR back to the pumper is 86 gpm, which issued from the EJECTOR at 30 psi pressure. This represents a

possible lift of 69 feet, (30 x 2.3), if friction loss did not exist. If one 1½ inch hose were used, this flow of 86 gallons per minute would result in 26 psi loss for each 100 feet of hose. It is plain to see that only 4 psi remains for lift, or about 9 feet. But if two 1½ inch lines were used, only 43 gallons would be flowing thru each hose. Referring to the friction loss tables, we find a loss of approximately 7 psi, leaving 23 psi available which represents nearly 53 feet lift.

PITFALLS IN EJECTOR OPERATION AND HOW TO AVOID THEM.

1. Friction loss in hose, because too small a hose is used, can void use of an EJECTOR.

   REMEDY. Use hose of size recommended in this article, or larger.

2. Kinks in return line can cause failure, since pressure from EJECTOR outlet is limited.

   REMEDY. Keep return line straight, especially at EJECTOR connection and where it empties into the tank.

3. Dirt and sand can be picked up and brought back to tank.

   REMEDY. Use strainer which is not resting on the bottom of the water source.

4. If EJECTOR is not submerged sufficiently, an air-funnel can develop so that EJECTOR is sucking air instead of water.

   REMEDY. Submerge suction end of EJECTOR at least 12 inches if possible.

5. When using an EJECTOR of 1/2 the volume of the pumper and pumping directly onto a fire, sufficient pressure may not be available to lift water to the tank. This would happen if a large nozzle tip was attached on the discharge line, and only a short hose lay is used.

   REMEDY. Use smaller tip on nozzle, or partially close shut-off nozzle on hose. Another solution would be for pumper operator to close down on valve on discharge line until proper pressure is secured. After the tank is full, water feeding ejector can be shut off and the entire output of the pumper used on the fire until the tank gets low, then opened again to fill tank.

6. Water drains from hose lines if engine stops. Then a reserve supply of water is again necessary before EJECTOR action can be started.

   REMEDY. Inspect footvalve on suction side of the EJECTOR.

A P P E N D I X

FRICTION LOSS IN HOSE

Shown in feet (head) and pressure in pounds per square inch.

Gallons per Minute	3/4" Hose		1" Hose		1½" Hose		2" Hose	
	Feet	Psi	Feet	Psi	Feet	Psi	Feet	Psi
5	9	4	2	1	.3	.1	0	0
10	32	14	8	3.6	1	.4	0	0
15	69	30	17	7.4	2	.9	0	0
20	115	50	29	12.6	4	1.7	1	.4
25	173	75	43.7	19	6	2.6	1.4	.6
30			61	26.5	8.5	3.7	2	.9
35			81	35.2	11	4.8	2.7	1.2
40			115	50	14	6.1	3.5	1.5
45					18	7.9	4.3	1.9
50					22	9.6	5.2	2.3
60					30	13	7.3	3.2
70					40	17.4	9.8	4.3
80					52	22.6	12.6	5.5
90					64	27.8	15.7	6.7
100					77	33.5	18.9	8.2
125					121	52.6	28.6	12.4

Note:- In the above table, psi multiplied by 2.3 gives feet (head).

EJECTOR PERFORMANCE

The following pages contain performance curves Figures 1 to 7 inclusive, for the seven EJECTORS tested.

One example is worked out to explain use of the curves. Refer to #3 EJECTOR.

Given a pumper rated at 15 gpm @ 250 psi, and a #3 EJECTOR. What output and lift is possible when the pumper is working at 200 psi? Start at (1) and follow dotted line up to (2). Eleven gpm (read on the left side of chart) is used by the EJECTOR. At this point (2), intersect the curve marked 60 psi, or 138 foot lift. So this 11 gpm can be lifted 138 feet. Since this is the amount pumped to EJECTOR, it is indicated that no water is picked up by the EJECTOR. Continuing up the 200 psi line to (3), intersect 50 psi or 115 foot lift. Reading gpm on the left side, find 16 gpm as the flow which can be lifted 115 feet. This shows 5 gpm picked up thru the suction (16-11).

Continuing up to (4), intersect curve marked 40 psi or 92 feet. The flow here is 20 gpm, indicating that 9 gallons have been picked up by the 11 gpm flow. At (5), maximum flow of 23 gpm is reached, which can be lifted somewhere between 69 feet and 92 feet, approximately 88 feet.

In this manner, it is possible to determine output and lift possible at any pressure the pumper is being operated.

#1 EJECTOR

Test Dates:
June & July 1950
May & June 1951

EJECTOR PERFORMANCE CURVES

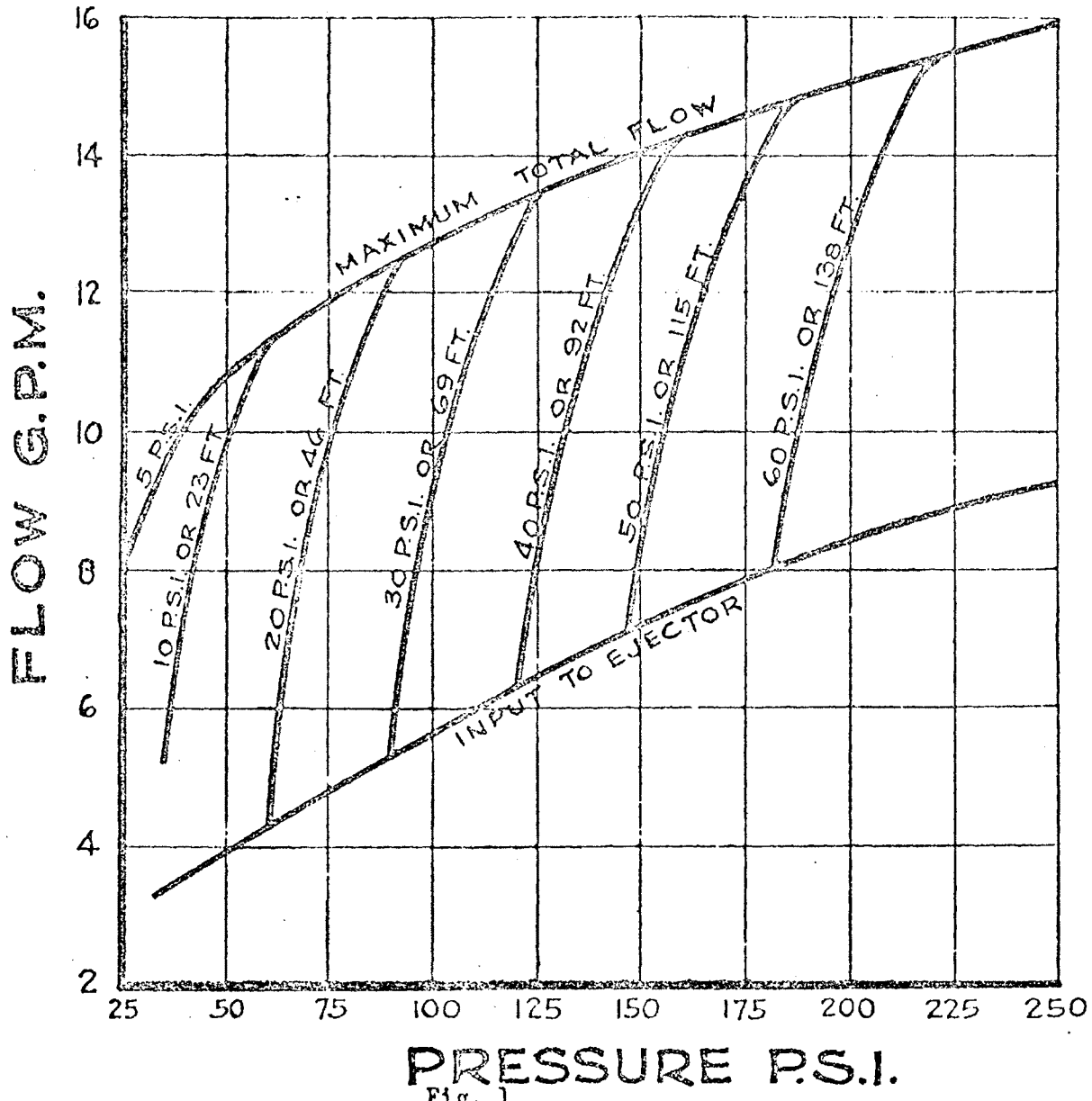


Fig. 1

* 2 EJECTOR

Test Dates:
June & July 1950
May & June 1951

EJECTOR PERFORMANCE CURVES

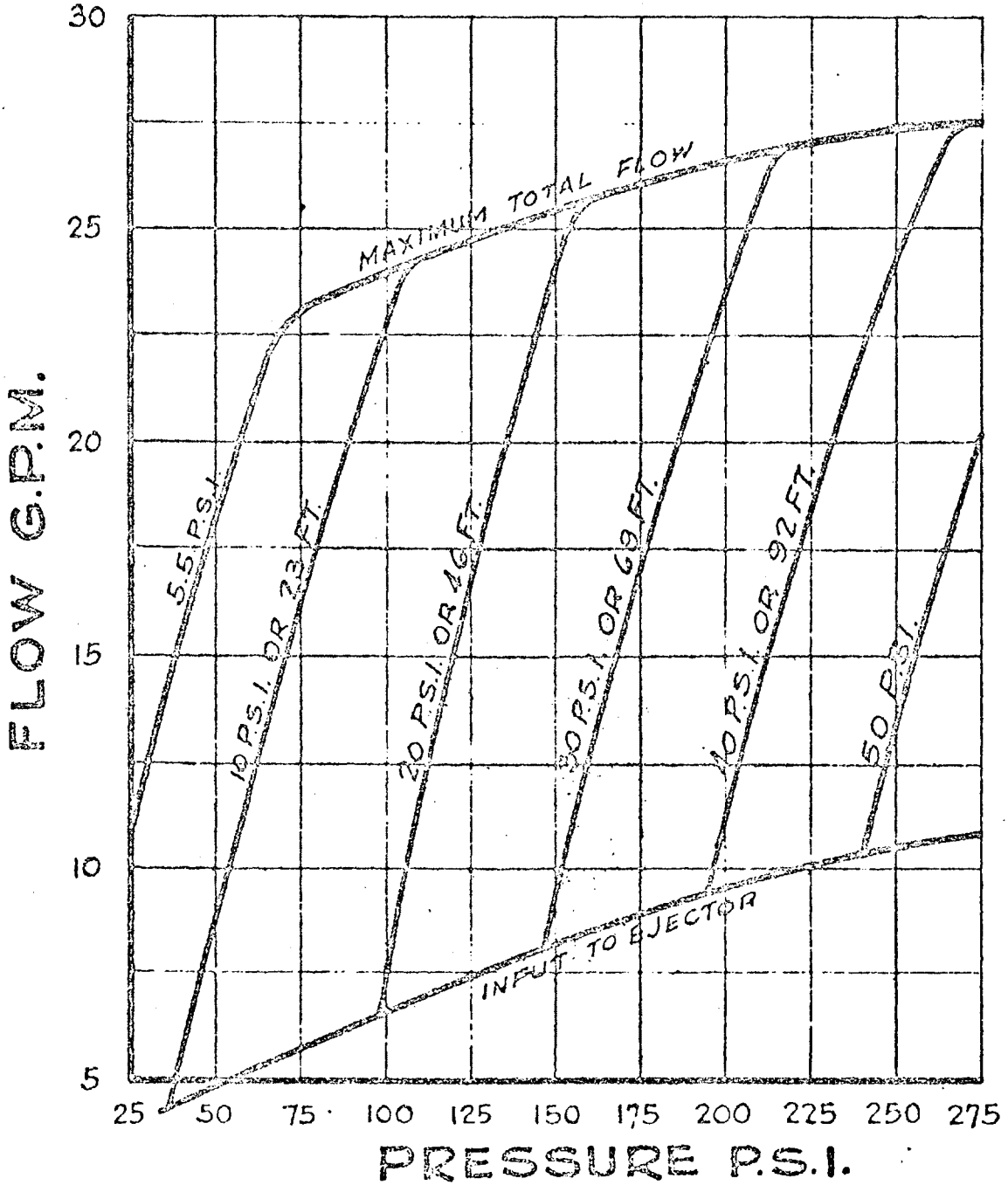


Fig. 2

#3 EJECTOR

Test Dates:
June & July 1950
May & June 1951

EJECTOR PERFORMANCE CURVES

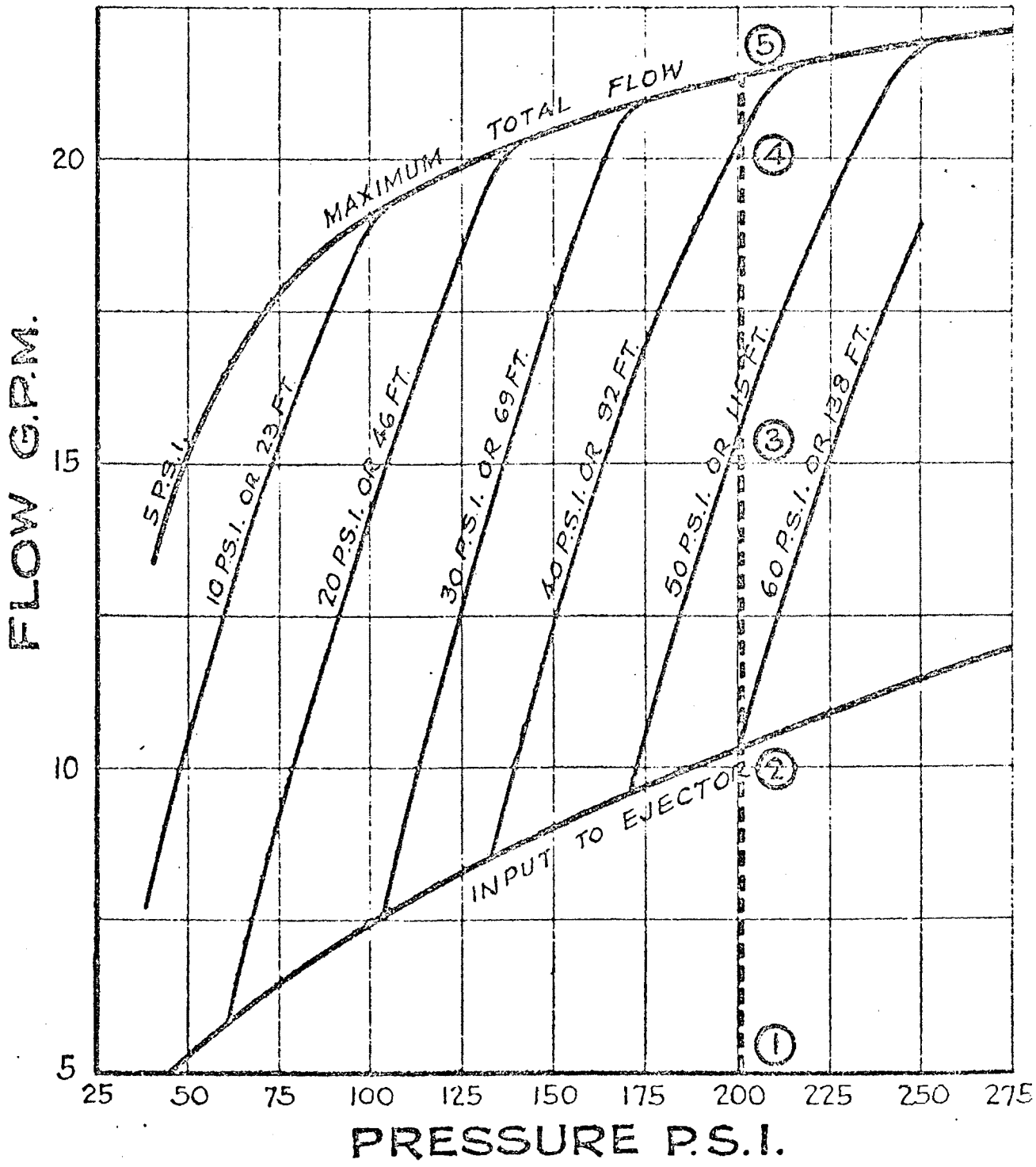


Fig. 3

#4 EJECTOR

Test Dates:

June & July 1950

May & June 1951

EJECTOR PERFORMANCE CURVES

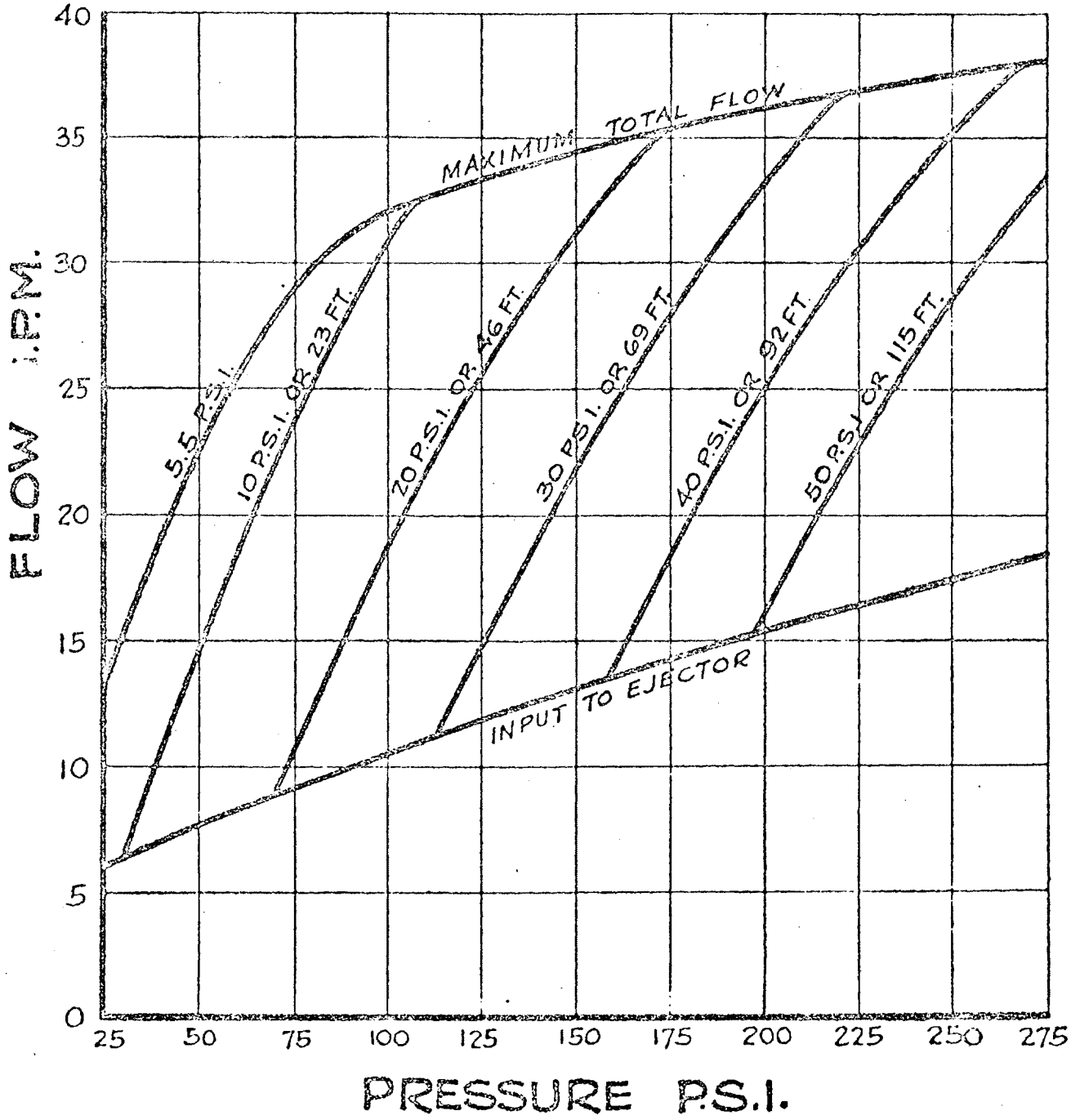


Fig. 4

#5 EJECTOR

Test Dates:
June & July 1950
May & June 1951

EJECTOR PERFORMANCE CURVES

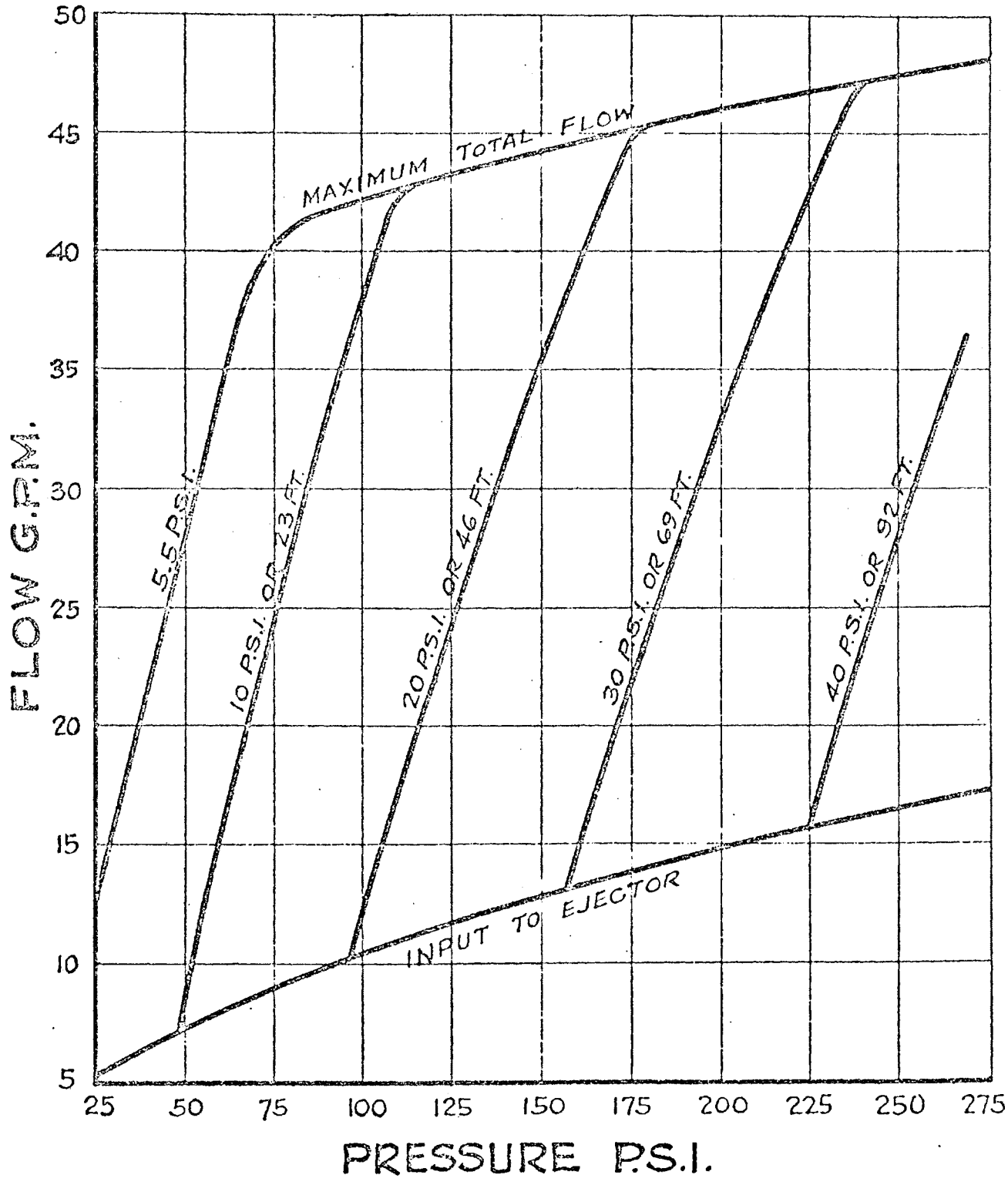


Fig. 5

#6 EJECTOR

Test Dates:
June & July 1950
May & June 1951

EJECTOR PERFORMANCE CURVES

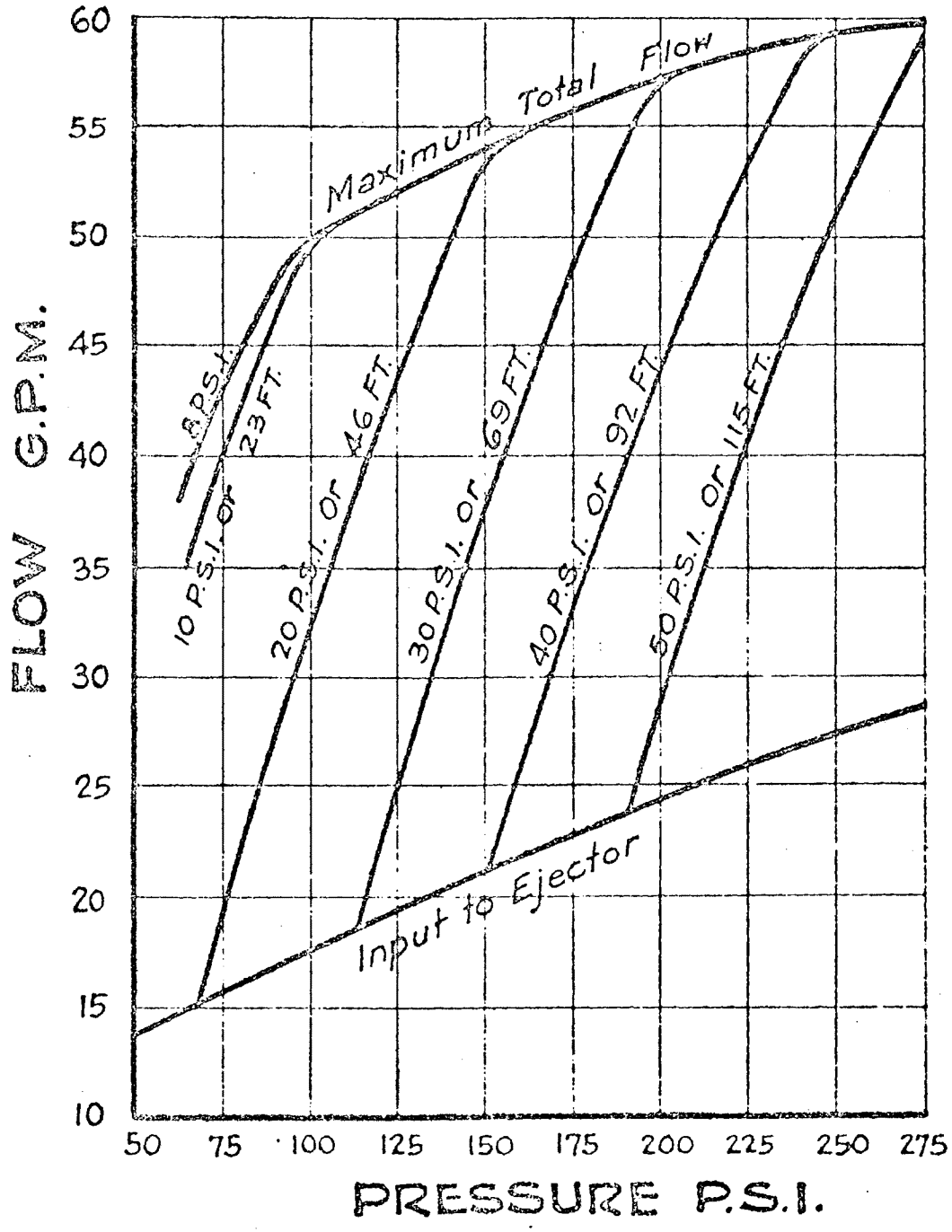


Fig. 6

7 EJECTOR

Test Dates:
June & July 1950
May & June 1951

EJECTOR PERFORMANCE CURVES

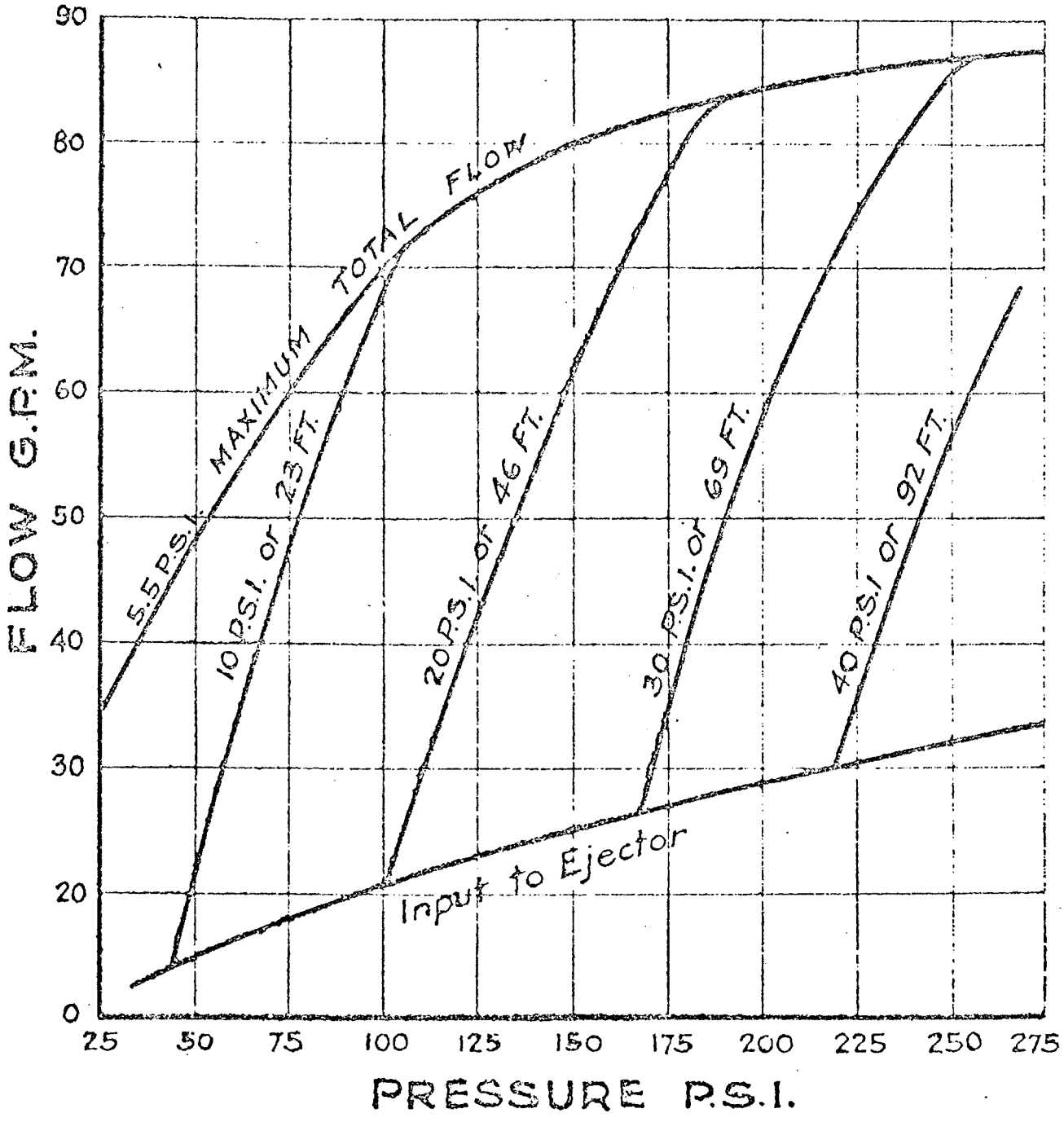


Fig. 7

PURCHASING EJECTORS

There are many manufacturers of EJECTORS. While those tested at Arcadia included Penberthy, Berkeley and Pacific Pump, they, by no means, cover the field.

In general, EJECTORS can be purchased through any large hardware outlet or plumbing supply source.

All manufacturers have performance curves for their EJECTORS and selection can be made so as to obtain performance comparable to those listed in this report.

MARKING EJECTORS FOR IDENTIFICATION

Each EJECTOR purchased should be stamped to facilitate identification in the field. EJECTORS which have been sent out by the Arcadia Equipment Development Center have the capacity at 250 psi pressure stamped in the intake end as follows:

Ejector No. 1 - 9	Ejector No. 4 - 17
No. 2 - 10	No. 5 - 16
No. 3 - 11	No. 6 - 27
	No. 7 - 32

CAUTION: Be careful when stamping EJECTORS. Stamp only on the thicker portions.

FITTINGS NECESSARY TO HOOK UP EJECTORS

The following table shows pipe connections necessary for each EJECTOR:

PENBERTHY EJECTORS

	Swivel Connection Female NPSH To Male NPT	Bell Reducer NPT	Bushing (Brass Preferred) NPT
No. 62 A	1"	1" to 3/8"	(Two) 3/4" to 1½"
No. 63 A	1"	1" to 1/2"	(Two) 1" to 1½"
No. 64 A	1"	1" to 3/4"	(Two) 1¼" to 1½"

BERKELEY EJECTORS

	Swivel Connection Female NPSH To Male NPT	45° L NPT	Nipple 2½" long NPT	Bushing NPT
00-9-18	1" to 3/4"	3/4"	1"	1" to 1½" (Two)
0-10-28	1" to 1"	1"	1"	1¼" to 1½" 1" to 1½"
0-12-38	1" to 1"	1"	1"	1¼" to 1½" 1" to 1½"
1-17-52	1½" to 1¼"	1¼"	1¼"	1¼" to 1½"

Note: (NPSH = National Pipe Straight Hose, sometimes referred to as PIP.

NPT = National Pipe Taper, referred to as IP.)